### The Large Retaining-Walls of Cournion, La Bastide, La Foret, and Cerbere.*

Important improvements in the construction of retaining-walls have recently been effected on the Southern Railway of France. The retaining-walls of Cournion, La Bastide, and La Foret are on the railway from Mazamet to Bédarieux, already partially opened, and to be completed in 1887. They have all been built on a specially economical type, consisting of a sloping face-wall with nearly parallel faces, and strengthened at the back by triangular counterforts, extending out to beyond the amount of overhang. The space between the counterforts is filled in with dry rubble walling, or with well-punned earth brought up in layers 8 inches thick. By this means a prism is formed behind the face-wall, exerting no thrust, and of which the weight and adhesion of the counterforts increase the stability of the wall in proportion as the batter of the face-wall is increased; also the thrust of the soil is thrown against the side-faces of the counterforts, and the cost of the masonry is reduced. In fact, as the batter of the face-wall is increased, the resultant pressure of the earth is reduced; and the necessary increase of the counterforts and of the backing is more than counterbalanced by the reduction in thickness of the face-wall, and eventually the thickness of the face-wall might be theoretically reduced to nothing, and serve only for protecting the surface at the back, resembling then the consolidation of cuttings by transverse buttresses. The Cournion wall retains an embankment of hard limestone; it varies in height from 5 feet to 62½ feet, and has a length of 1,390 feet. At the highest portion, the wall has a thickness of 4½ feet at the top; the face-wall has a batter of 1 in 5 at the back throughout, and a batter in front of 1 in 5 for 30 feet down, and 1 in 3 below; and the counterforts are placed 19 feet apart, and are 4½ feet thick. The intervals between the counterforts are filled with limestone laid by hand. The mean thickness of this wall is 7¾ feet, whereas the usual formulas would indicate 11½ feet as the proper thickness, so that the new type effects a saving of about one-third. The Bastide wall, 133 feet long and from 18 to 24 feet high, has a face-wall 1 foot thick at the top, with a batter of 1 in 4 in front, and 1 in 4½ at the back; and its counterforts, 1⅔ feet thick, are 16¼ feet apart, with an intermediate backing of dry rubble. Its average thickness is 1 foot 10½ inches, instead of 6½ feet as indicated by formula; so that the large saving of over two-thirds has been accomplished in this instance. The Forêt wall, 262 feet long and 16½ feet high, supports an embankment of schistose and gneiss rock; its face-wall has a batter of 1 in 5, and a uniform thickness of 3½ feet; and its counterforts are 13 feet apart, with intermediate backing of the materials of the embankment laid by hand or with a hammer. Its mean thickness is 3 feet 8½ inches, as compared with the theoretical thickness of 5 feet 7 inches, affording a saving of one-third. The Cerbère wall, built for the Southern Railway at the Spanish frontier, is both a retaining-wall and a two-storied viaduct; it has a total length of 1,755 feet, of which a central portion, 1,010 feet long, is arched, and the rest at each end is solid. It is from 59 to 75½ feet high, and the piers of the viaduct are 39½ feet apart; it contains 39,000 cubic yards of masonry, and its contract price was £40,000. The front of the viaduct faces the sea; and the back supports the embankment, which, taking its natural slope, rests upon the lower story of the viaduct, its foot being maintained by a dwarf-wall on the front face; and below, the slope is steepened by dry stone pitching, quarried from the neighboring rocks, so as to reduce, as much as possible, the width of the viaduct.

*From Abstracts of Papers; Inst. C. E.

### Engineers' Surveying Instruments.—Their Construction and Use.

V.

Written for ENGINEERING NEWS.

I. O. BAKER, C. E., PROFESSOR OF CIVIL ENGINEERING, UNIVERSITY OF ILLINOIS.

#### THE LEVEL.

1. QUALITIES DESIRED IN A LEVELING INSTRUMENT.—The main qualities to be secured in a leveling instrument are delicacy of level, stability and defining and magnifying power in the telescope. The optical qualities of the telescope have already been discussed, but it may not be amiss to repeat that the optical qualities should be correctly proportioned to the sensitiveness of the level bubble. Of two levels in the writer's possession, one had a magnification of 17 and a radius of the bubble of 84 feet, and the other a magnification of 27 and a radius of 22 feet; the simple expedient of changing the bubbles improved both instruments very much. A third instrument is inferior to the other two in definition, although it has a bubble of 165 feet radius.

The stability of the instrument depends very much upon the leveling screws and the manner of connecting the instrument with the tripod-head. This point was discussed under the transit; but we repeat that three screws give greater stability than four; and, in either case, the distance between opposite screws should be as great as possible. This item is of greater importance in the level than in the transit. It seems to be self-evident that the center of gravity of the instrument should be as near to the tripod-head as possible, but this is a common defect.

However good the other parts of the instrument may be, the accuracy of the work depends upon the sensitiveness of the bubble. It must be remembered that, although a sensitive bubble may not remain exactly stationary, it will still give better results than a sluggish one, which shows no movement when the instrument is slightly displaced.

2. SENSITIVENESS OF BUBBLE.—The sensitiveness depends upon the radius of curvature, or, what amounts to the same thing, upon the distance the bubble moves for any change of inclination.

To measure the sensitiveness, proceed as follows:—Bring the bubble nearly to the center and sight upon a rod held vertically. Raise or lower one end of the level, by operating the foot screws, until the bubble moves about as far to the other side of the center, and sight at the rod again. Let $h$ = the difference of rod readings; $D$ = the distance from the instrument to the rod; $m$ = the distance the bubble moved; $d$ = the length of one division of the scale: $n$ = the number of divisions bubble moved, $m = nd$; $I$ = the change of inclination of the line of sight; $R$ = radius of curvature of the level tube. Then, in Fig. 1, we have, from the approximately similar triangles $A\,B\,C$ and $O\,P\,Q$. $R = \frac{D}{h} m = \frac{D}{h} nd$,

and $tan\ I = \frac{h}{D}$; approximately $I''\ tan\ 1'' = \frac{h}{D}$;

hence $I'' = \frac{h}{D\ tan\ 1''} I''$ is the value in seconds of arc of $n$ divisions of the scale, consequently the angular value of one division in seconds

$$= \frac{h}{n\,D\ tan\ 1''} = \frac{h}{0.000005\,n\,D.}$$

The sensitiveness of a bubble is generally stated by giving the angle corresponding to a movement of an inch. Good engineer's levels have a motion of 200″ to 120″ per inch, or a radius of curvature of 80 to 140 feet. Levels of precision have a motion of about 75″ to 100″ per inch, or a radius of curvature of 400 to 160 feet.

3. DIFFERENT FORMS OF LEVELS.—Leveling instruments may be grouped in three classes. The first includes all instruments that can be adjusted by reversals; the common wye or Y-level is a representative of this class. The second includes all that can not be adjusted by reversals; the "dumpy level," is a type form. The third includes all instruments whose errors of adjustment may be wholly eliminated by a system of double observations; the instruments of this class are usually called "levels of precision," and are used only where extreme accuracy is aimed at.

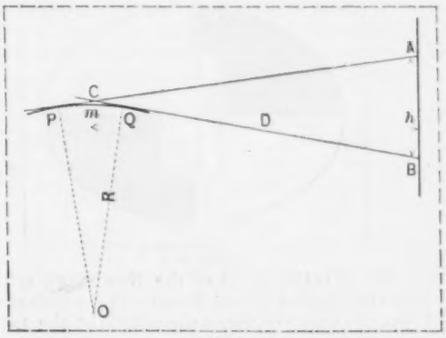



Fig. 1.

The distinguishing characteristic of the Y-level is that the telescope may be revolved about its own axis, and turned end for end in its bearings; the only advantage of this construction being to facilitate the adjustment of the instrument. "The Y-level is easily adjusted and nearly always needs it." It is the favorite with American engineers.

The "dumpy level" is the name given to that form of leveling instrument in which the telescope is attached to the bar in such a way as not to admit a rotation around the axis of the telescope, nor allow of reversion end for end. The telescope is usually inverting, and therefore shorter than the one commonly used on leveling instruments, hence the name dumpy; however, this construction can be employed with an erecting as well as with an inverting telescope. English engineers use this form exclusively.

Without doubt the American engineers could profitably follow the English in using the dumpy to the exclusion of the Y-level. As ordinarily made, the former has the advantage of an inverting telescope as has been discussed; it is also more simple and compact. If equally well made, it is capable of doing as accurate work as the more elaborate and more expensive Y-level. The only disadvantage charged against the dumpy is that it is not so easily adjusted, although it is admitted that when once adjusted it retains the adjustment very much better than the Y level. The last is a very important advantage, for unless an instrument is in adjustment the work is nearly certain to be inaccurate.

The writer firmly believes that the dumpy is as quickly and as easily adjusted as the Y level. Finally there are a few particulars connected with the manufacture of the instrument in which the general design of the dumpy is superior to the Y level; as these would probably be inappreciable, except in very accurate work, they will not be discussed here.

TARGET RODS.—There are two classes of leveling rods: 1, target rods, those in which the line of sight is always directed to a movable target, the position of which is read by the rod-man; and 2, self-reading or speaking rods, those in which the graduation is such

that the position of the line of sight can be read with the telescope. The well known New York rod is an example of the first-class. The Philadelphia rod may be used either as a target or a self-reading rod.

The target is a piece of brass or iron which can be moved up or down the rod, or clamped in any position. It carries a scale or vernier to subdivide the least space on the rod. The face of the target should be painted of such a pattern that it may be precisely bisected by the horizontal cross-hairs. Some of the many varieties are given in Figs. 2-4.

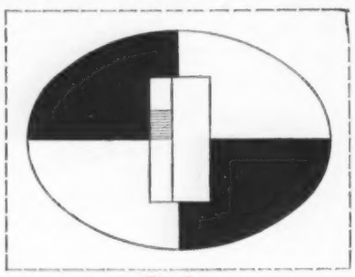


Fig. 2.

Fig. 2, is the target of the New York rod; the design is not good, because the cross-hairs may be above or below the middle of the target by its full thickness, as magnified by the eye-piece, without the error being perceptible.

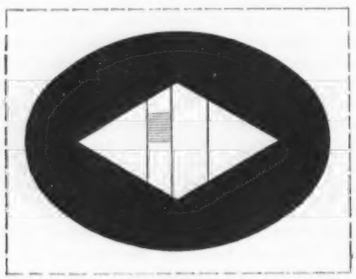


Fig. 3.

Fig. 3, depends upon the nicety with which the eye can determine whether a line bisects an angle; this can be done very accurately by noticing the length and position of the two points formed on either side of the hair.

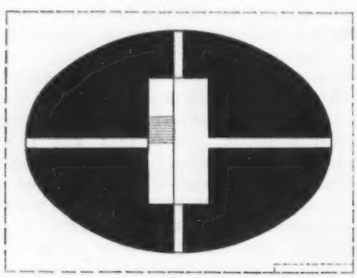


Fig. 4.

Fig. 4, depends upon the accuracy with which the eye can bisect a space.

Black and white are best for visibility; but red and white are most easily distinguished among trees, shadows, etc., and red gives the stronger contrast with the cross-hairs. Probably red and white are the best for Fig. 2, and black and white for Fig. 4.

5. SELF-READING RODS.—The most common rod of this class is the Philadelphia rod. The graduation is in feet and tenths, the figures indicating feet are red, the tenths black. The figures are six-hundredths in height, placed with centers over the marks; sometimes the bottom of the figures is placed on the line, in which case the figures may be eight-hundreths high. To make a reading greater than 7 feet, without a target, the rod must be extended to ts greatest length.

A few of the many patterns which have been proposed for self-reading rods are shown in Figs. 5-8.

The advantage of the form of graduation of which Fig. 5 is a type, is distinctness and isibility. The angles of the figures indicate

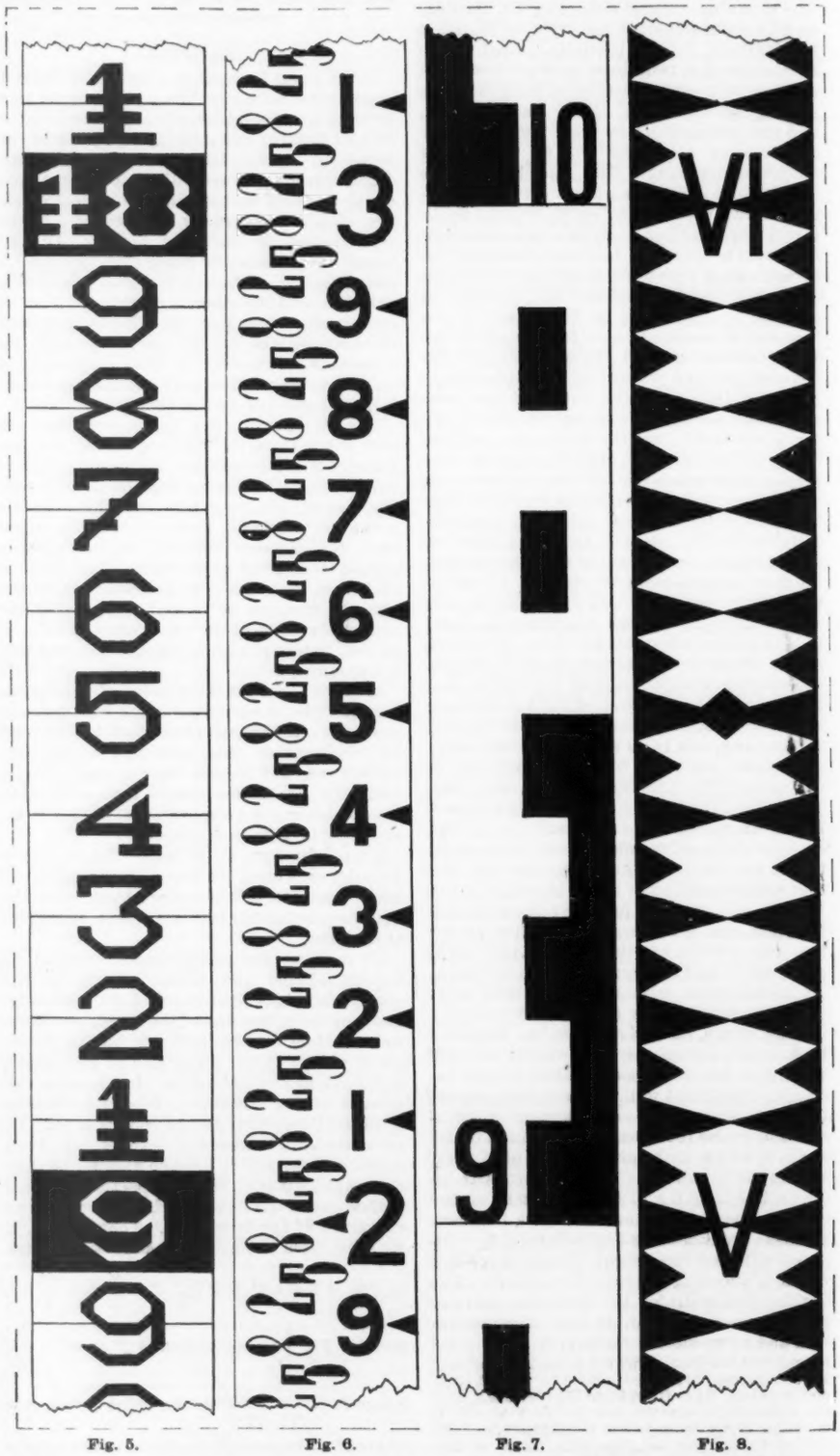


Fig. 5. Fig. 6. Fig. 7. Fig. 8.

fractions of tenths; the figures may be placed with centers or with bottoms, on the lines. The graduation given is suitable for short sights; for longer ones the figures are made larger, and only those for the even tenths are marked.

Fig. 6 shows the Francis rod, which is claimed to be a complete graduation to hundredths without visual division, and can be read without counting. The foot marks are red and larger than the tenths. It is best adapted to short sights.

In its essential features, Fig. 7 is the favorite British self-reading level rod. The graduation is to hundredths. Although the one shown is better than the typical English rod, it cannot be considered a good one for the same reason for which the usual target to the New York rod condemned in a previous paragraph.

The principle of the Texas rod, Fig. 8, is of frequent application in making self-reading

rods. It is superior to that of Fig. 7 in that it obviates the error due to the thickness of the cross-hairs. The points indicate tenths, but it can be read by estimation to hundredths; it is possible to make the reading much more accurately by dividing the oblique side of the triangle, than could be done when the rod is graduated according to the principle of Fig. 7. This form of graduation reduces the difficulty of counting a number of small divisions, and also the possibility of gross mistakes.

Any pattern suitable for a stadia rod, samples of which will be given in the next article, can be used in making a self-reading leveling rod. The pattern may be painted or stenciled directly upon the wood, or it may first be drawn or painted upon paper, and then fastened on the rod with varnish or any glue not soluble in water. Strips of cloth or paper containing scales for this purpose are sold by dealers in engineering stationery. The graduation will keep cleaner and last much longer, if the face of the rod is recessed slightly to receive it. The rod can be made of a light board hinged in the middle, so that it may be folded to protect the face and for convenience of transportation; it is held open by a button or bolt on the back. Stencils can be cut out of a sheet of writing paper which has been varnished or oiled.

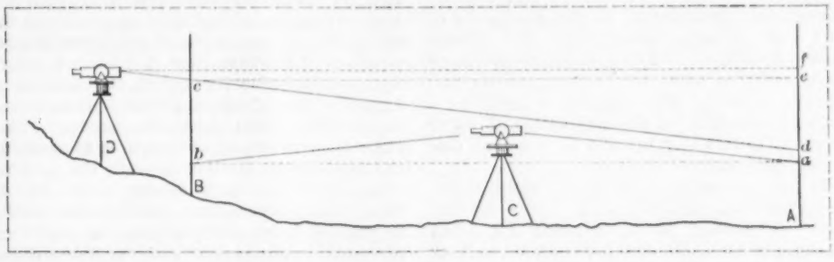



Fig. 9.

6.—Target *vs.* Self-Reading Rods. Probably the former are the more common now, but as the advantages of the latter are becoming better understood, they are being more generally used. The chief advantage of self-reading rods is the saving of time. Setting the target to some exact point in accordance with directions given from a distance, is a tedious process at best. After a little familiarity with the pattern of the self-reading rod, the height of the line of sight upon the rod can be read very quickly.

On the other hand, target rods must of necessity be capable of greater accuracy than self-reading ones, but the difference in accuracy is not so great as might at first seem; the accuracy of a level determination depends upon a number of things of which the reading of the position of the line of sight upon the rod is one of the least important, all of the others being independent of the kind of rod.

Reading the position of the target to 1,000th is unnecessary and useless, unless all the other parts of the work are equally precise. The thing to be sought is corresponding accuracy in all parts of the work.) If several independent readings of a rod be made upon the same point, the difference between the various readings will probably be considerably larger than the probable error of reading a self-reading rod.

In precise leveling self-reading rods are used, the position of two or three hairs, generally the latter, are read to reduce the error of reading; the mean of these is used as the rod reading. For a single observation, a target rod is more accurate than a self-reading one; but three observations, as above, are probably more accurate than a single observation upon a target, and can be made in about the same time.

(TO BE CONTINUED.)

## ACCIDENTS IN MINES.*

### VII.

### Explosive Agents, and Particular Methods of Using Them.

(*Continued from page 295.*)

Your Commissioners were encouraged by these results to continue trials of the form of dynamite-water-cartridge described; several series of experiments were therefore carried out under their instructions, partly in the open air and partly under-ground. The general method of conducting these experiments, which were commenced in March, 1881, was that first adopted at Woolwich in the winter of 1880, but the cubical canvas gas-chamber was fitted with a simple stirring arrangement for expediting the mixture of gas with the air, and a Davy or other test lamp was introduced into the chamber by which the proportion of gas used in each experiment was approximately determined, the lamp being observed through a small glass window let into one side of the cube. It need only be further mentioned here that the materials composing the outer case or water-tube, and the water-proof envelop of the charge, as well as the electrical detonators, were variously modified with a view to cheapening the mode of operation; when, in the later experiments, the shot-hole was perfectly solid (as in the case of the holes in the metal blocks frequently used), the water-tube was dispensed with, the charge being simply placed into the shot-hole, which was then filled up with water, so that the latter completely enveloped the charge.

In the first series, carried out in the open air, near Bute Dock, forty-four water-cartridges containing dynamite charges (one of them was blasting gelatine) were fired, the mouth of the blast-hole being surrounded by an explosive gas and air mixture. The charges ranged from three to four ounces; in the great majority of the shots the cartridges (or water-tubes) were 2 feet in length, and were fired without tamping; 4 and 6 inches of clay tamping were applied in a few instances. In two experiments the water had leaked out of the cartridges before the shots were fired, leaving forty-two shots which were fired under proper conditions. Of these, thirty-five shots failed to fire the gas mixture; in one instances its ignition was doubtful, and six shot fired the gas. A dynamite shot fired in the ordinary way inflamed the gas-mixture. Eight shots were fired into gas with powder-charges, ranging from four to six ounces, inclosed in water, several inches of clay tamping being applied in all instances. The water had leaked out of the cartridge of one shot; of the other seven, two did not fire the gas-mixture, the other four did. As already stated, six shots were fired upon the plan which Dr. McNab originally adopted, a long cylinder filled with water being placed over the charge; of these, four fired the gas; with one the ignition was doubtful, and one failed to ignite the gas. It could not be said, therefore, that any practical differences existed between the two methods of using water, *as applied to gunpowder*.

The experiments made in coal at Bute Merthyr Colliery, confirmed those carried out in Garswood Hall Colliery in 1880, in regard to the very efficient action of the dynamite water cartridge in bringing down coal in large masses. They also showed that the firing of these cartridges, especially in hard places where the effects of blown-out shots were obtained, was, in the majority of cases, attended by the projection of some sparks, the amount of fire observed being, however, very small as compared with that produced by firing dynamite-charges under ordinary conditions, and quite insignificant in comparison with the volume of flame and fire projected by powder shots.

The results of these numerous experiments on the employment of *dynamite charges enclosed in water* appear to warrant the conclusion that this method of shot-firing diminishes, by a degree which may certainly be regarded as important, the risks which attend shot-firing when powder is used, either in the ordinary way or in conjunction with water in localities where an *explosive* mixture of gas and air may possibly at some time or other occur, while the effectiveness of the shots, as regards coal-getting, is in no way inferior to that of powder blasting. On the other hand, it is conclusively demonstrated that the adoption of this system of blasting would not *ensure* immunity from accidents if practised in workings *where fire-damp exists in proportions sufficient to produce an explosive mixture with the air*. That such a state of things never exists at the present day, except when the firing of a shot is shortly preceded by a sudden outburst of gas in the vicinity, need scarcely be stated; but as the inquiries into some accidents appear to have warranted the conclusion that they have been due to the firing of shots under those special circumstances the employment of the water-cartridge could not have been absolutely relied upon to have averted a catastrophe of that class.

As, however, it has now been conclusively established that the presence of only *small* proportion of fire-damp in air in which coal-dust becomes thickly suspended, constitutes an element of great and comparatively frequent danger, and as even certain very inflammable dusts may, in the entire absence of fire-damp, give rise to disastrous explosions when they are subjected to the action of the flame from a blown-out-powder-shot, it became a matter of the very first importance to determine conclusively whether the sparks which are liable to be projected, though in comparatively small quantities, by a dynamite-water cartridge, are capable of igniting very fine and highly inflammable coal dust *per se*, or of inflaming coal dust in the presence of small proportions of fire damp, insufficient in themselves to constitute any source of danger.

The more recent Neunkirchen experiments appear to have furnished at any rate some ground for the belief that the most inflammable coal dusts, which are invariably fired by a blown-out powder shot, cannot be ignited when thickly suspended in the air, by the stream of sparks emitted from a dynamite shot *fired in the ordinary way*. There appears room for doubt whether in those experiments the conditions essential for the production of a veritable blown-out shot were fulfilled, but at any rate there were decisive indications of a very important difference between the behavior of the inflammable dust when subject to the action of *heavy dynamite* shots and of *blown-out powder* shots. When, therefore, the

*From "Final Report of Her Majesty's Commissioners appointed to inquire into Accidents in Mines, etc," 1886.

production of sparks is reduced to a minimum through the agency of the water-cartridge, the temperature of white-hot sparks being at the same time generally reduced to a perfectly safe extent, there appear strong *prima facie* grounds for the presumption that dynamite may be used in that way, with perfect safety, in workings where the most highly inflammable dust abounds, *in the absence of fire-damp*. The great importance of obtaining positive information on this point, and of determining by trustworthy experiments upon a sufficiently extensive scale how far this condition of things is effected by the existence in the air of proportions of fire damp, ranging up to those which are feebly explosive, led your Commissioners quite recently to have a further series of experiments carried out which demonstrated the following points in a sufficiently conclusive and ample manner to allow of their being put forward with confidence.

1. Dynamite charges enclosed in water, or dynamite-water cartridges, 18 inches long and upwards, may be fired, so as to produce blown-out shots, with perfect security in mixtures of air and fire-damp in which the proportion of the latter ranges up to six volumes per 100 of air (or between six and seven), and in which a very fine, dry, and inflammable coal dust is thickly suspended at the moment that the shot is fired. In 32 experiments, in some of which the gas was present in proportions not much below those needed to produce a highly explosive mixture, and in all of which coal-dust was very thickly suspended when the blown-out shot was fired, not one case of ignition of the gas and dust mixture occurred.

2. So far as a limited number of experiments justifies the conclusion, it appears that compressed gun cotton, tonite, cotton powder, or potentite, blasting gelatine, and gelatine-dynamite may be used with equal safety through the agency of the water-cartridge, in the presence of mixture of air and gas nearly approaching the most exclusive proportion, and with coal dust thickly suspended in them. These results have received important confirmation from a series of experiments made at Mill Bank Colliery, Newcastle, Staffordshire, in the presence of Mr. Sawyer, Inspector of Mines, with water-cartridges and gelatine-dynamite, by some gentlemen interested in a patent which was obtained for the water cartridge, long after its nature and effects had been made public unreservedly by Sir F. Abel.

3. Under the same conditions as specified in 1 and 2, blasting *powder cannot be employed* with any certainty of safety. Of seventeen experiments with powder-charges enclosed in water-cartridges and fired in the presence of air containing coal-gas in proportions ranging up to 6 per cent., coal dust being thickly suspended therein at the moment the blown-out shot was fired, eight produced no ignition of the gas and dust mixture, but in the other nine cases a partial or complete inflammation occurred. Two of the experiments, in which no ignition of dust and gas occurred, were made on a day when the atmospheric temperature was low, and other results indicated that the sensitiveness of the dust to ignition was very greatly affected thereby. The substitution of water tamping for the water cartridge under corresponding conditions, with the employment of powder was found to be attended by the same element of certainty, and therefore of danger.

4. The employment of any one of the "high" explosives in conjunction with water-tamping, in place of the water-cartridge, *i. e.*, a cylinder or column of water being placed over the separately confined charge in the shot-hole, appeared, so far as a limited number of experiments went, to afford with them the same security as the water-cartridge, when blown-out shots were produced under the conditions specified above.

Some observations, made during this series of experiments, which was conducted with the aid of indispensable facilities most courteously and liberally afforded by Messrs. Martin of the Dowlais Iron and Steel Works, led to a careful consideration of the mode in which the water column might operate in extinguishing flame or lowering the temperature of the highly heated matter projected by a blown-out shot, and to the conclusion that the thorough dispersion, in a finely-divided condition, of the column of water above the charge was not uniformly accomplished, the liquid being projected at times by the blown-out shot to a more or less considerable extent *en masse*. It was thought that this might be prevented by distributing the water through a very porous solid body, whereby an initial interruption, throughout, in the continuity of the mass of water placed over the charge would be secured, and its consequent thorough disintegration, or complete dispersion as fine spray, ensured. Moss suggested itself as a suitable medium for the application of water tamping in this way, being a very spongy material, and really procurable.

In the first series of trials with water tamping applied through the agency of a spongy body, blown-out shots, obtained by firing charges of two and one half ounces to four ounces of dynamite in the vertical hole contained in one of the steel blocks used in these experiments were projected into air containing proportions of coal-gas approaching that necessary to produce an explosive mixture, and in which very fine and inflammable coal dust became thickly suspended at the instant the shot was fired. Over the charge in the shot-hole, moss, freshly taken out of water in which it had been thorougly soaked, was placed, being simply pressed into the hole very gently, so that the water was squeezed out as little as possible, being re-absorbed when the pressure was removed. As the charges used did not accurately fit the shot-hole, it was found convenient, after the first four experiments, to close up the hole over the charge by ramming in a little paper. The first piece of wet moss then introduced was rammed down somewhat firmly, and the remainder was merely loosely put into the hole. The length of moss and water tamping used was gradually diminished from 13 inches to 9 inches, while the charge of dynamite was increased from two and one half ounces to four ounces, the largest charge being used with the shortest length of tamping. The gas and dust mixture was not in any case inflamed, and no sparks were seen to be projected by daylight. In similar experiments performed at night a few sparks were seen to be projected through the dust cloud, which was thickly suspended in the gas and air mixture. From a dynamite water cartridge, fired under similar circumstances at night, a few sparks were also seen, and a portion of the projected water was rendered dimly visible by the explosion of the charge, which was not the case when the moss and tamping was used.

The success which attended these first trials of this form of water tamping, led to the firing of blown-out dynamite shots, prepared in the same way, into highly explosive mixtures of gas and air; the length of tamping used (with 2.5 ounces dynamite charges) being gradually reduced from 13.5 inches to 4 inches, and in no case, in 11 experiments thus varied, was the gas mixture inflamed. The same negative results were obtained in firing blown-out shots with compressed gun-cotton, tonite, blasting-gelatine, and gelatine-dynamite. With ordinary blasting powder, however, the gas-mixture was exploded by blown-out shot produced with 12 ounces and ten ounces and having respectively 8.5 and 10 inches of moss and water tamping over the charges.

We consider that these experiments have conclusively demonstrated the efficiency of the simple application of porous tamping thoroughly soaked with water in preventing the ignition, by blown-out shot produced with dynamite and other high explosives, of an explosive mixture of coal gas or fire-damp and air, and of mixtures of gas and air with very inflammable coal dust thickly suspended in them. This mode of applying water as tamping and as a protective agent obviously possesses the advantages of simplicity and cheapness over the water cartridge, and over water tamping applied in any other way. The water-cartridge is on an equality with sponge and water-tamping, in preventing the ignition, by blown-out shots produced with the high explosives, of coal-dust suspended in the air in the presence even of considerable proportions of fire-damp, but it does not afford that absolute security against the ignition of explosive gas-mixtures by blown-out shots produced with those explosive agents, which there is every reason to believe is attained by the use of water applied through the medium of any very porous or spongy solid, which, when thoroughly saturated with it, can readily be inserted into a charged shot-hole. A few experiments, made in hard shale in underground workings, with dynamite-charges contained in water-cartridges, and with others covered with moss- and water-tamping, appeared to show that the explosive did equally good work when applied in the two ways, and it should be stated that no difficulty was experienced in applying the moss- and water-tamping in these experiments, in holes which had a slight upward inclination.

Some experiments have also been made under our instructions in coal with dynamite, and more particularly with gelatine-dynamite, employed in conjunction with moss- and water-tamping, for the purpose of ascertaining whether the shattering action of the violent explosives (which place them at a disadvantage as compared with powder *when applied in the ordinary way*) is modified, and assimilated to the action of mild mining powder, to the same extent by water-tamping, applied through the medium of a porous body, as it has been conclusively proved by many practical trials, to be through the agency of the water-cartridge.

The results include some modifications of the mode of applying the moss- and water-tamping, as well as a few results obtained under corresponding conditions with the same explosive used with ordinary tamping. They should be compared with the results obtained, in coal, etc., with the use of the dynamite-water-cartridge in 1881-2. They show that the moderating effect of water upon the local, disintegrating action of a charge of one or other of the violent explosives is not uniformly as great when the liquid is applied through the medium of a porous solid used as tamping, as when the charge is *enveloped* in the liquid which extends in a continuous column to some distance up the shot-hole, but that even this comparatively simple method of applying water changes, to a very considerable extent, the shattering effect exerted by the detonation of an explosive of the dynamite class, into the rending or cleaving effect exerted by powder or other similar explosive preparation, which is comparatively gradual in its action. There is no doubt that this modifying effect can be still further increased by adopting the simple auxiliary step of introducing into the blast-hole after the charge has been entered (when the position of the hole permits) sufficient water to completely envelope it, thus filling

up with the liquid any air-spaces existing between the charge and the side of the hole, the charge, thus enveloped, being then covered with a sufficient quantity of moss-and water-tamping.

The employment of ordinary tamping, in conjunction with the moss-and water-tamping, to an extent sufficient to occupy about one-half the length of the shot-hole, ensures the execution of efficient work in hard coal or stone, by preventing the loss of force consequent upon the comparatively ready projection of the loose moss-tamping and water from the hole. Under these conditions any of the known explosives of which nitro-glycerine or gun-cotton are the important constituents, applied in conjunction with a very spongy tamping saturated with water, to blasting in shale or stone wherever gas alone and in abundance, or gas and coal dust, may occur, presents unquestionable advantages in regard to safety, supplemented by the important merits of comparatively great simplicity and cheapness. These particular merits become decidedly enhanced by selecting, as the particular violent explosive agent to be used, one which is not affected by direct immersion, even for some considerable time, in water, and a corresponding advantage is, it need hardly be said, secured to the water-cartridge by the employment of an explosive of that particular character. Nobel's blasting gelatine is the typical explosive which fulfils this condition, but its perfect detonation is not to be thoroughly relied upon unless it is confined very strongly, and hence the requisite confidence in its doing the desired work might be wanting if it were used in conjunction with the sponge- and water-tamping, or with the water-cartridge, without either of these being supplemented by a considerable amount of ordinary tamping. The material known as Nobel's gelatine-dynamite, which is intermediate in character between blasting gelatine and the ordinary dynamite, shares, however, with the former the advantage of not being affected by direct immersion in water, while it is as readily detonated as ordinary dynamite. This combination of qualities renders it peculiarly suitable for use with the water-cartridge or with the sponge-and water-tamping, (as demonstrated by our most recent experiments, and also by those lately made at Mill Bank Colliery, in Staffordshire), because charges of this material need not, for employment in conjunction with water in either of the ways described, be specially protected by waterproof envelopes.

Your Commissioners feel much satisfaction at having been able, through the results of the special labors of one of our Members and of Mr. William Galloway, to pursue the subject of the application of explosives in coal-mines to such definite issues as to warrant the conclusion that the prescription of due regulations for promoting the prevention of accidents from explosions in dry coal-mines where fire-damp is liable to occur in abundance, or where dust-accumulations exist, while fire-damp may at the same time either locally or generally pervade the air of a mine, does *not* necessitate the prohibition of shot-firing in such mines, provided always that it be carried out only with explosives of certain kinds, employed according to certain prescribed methods, the adoption of which has been demonstrated to secure safety against accidental explosions, and to be unattended by practical difficulties. On the other hand, the results of our experiments have conclusively demonstrated that the use of powder in such mines should be prohibited, unless accumulated dust be in the first instance removed, as completely as practicable, from the vicinity of the place where the shot is to be fired, such removal to be followed by a copious watering of the place and the face.

It may be desirable briefly to recapitulate the facts established by our deliberations upon which this conclusion is based.

1. The employment of nitro-glycerine preparations, such as dynamite and gelatine-dynamite, or of such gun-cotton preparations as compressed gun-cotton, cotton-powder, tonite, or potentite, in conjunction with the water-cartridge, secures safety against the production of explosions, even by blown-out shot, in mines or workings where the air may contain a highly inflammable dust, thickly suspended in it at the moment the shot is fired, besides any proportion of fire-damp below that needed to produce a violently explosive mixture of the gas and of air. Moreover, when used in this way, they efficiently replace ordinary mining powder for working in coal, as the effect of the water-cartridge is to deprive them of their local or shattering action, and to cause them to exert a rending and cleaving action, like that of powder, whereby they bring the coal down in large masses, producing at any rate not more small coal than powder-shots do. If used in hard coal or stone they should only occupy about one-half the length of the shot-hole, the outer portion being filled with ordinary tamping. The water-cartridge can be so simply and cheaply constructed as to add but trifflingly to the cost of shot firing, especially if an explosive of the nature of gelatine-dynamite be used, which is not at all affected by direct immersion in water. The employment of the water-cartridge, with any of the "high" explosives, is unattended by any restrictions, its nature and action having been fully described in public prints, as well as publicly demonstrated, long before the date of any patents for water-cartridges.†

2. The employment of any of the explosives of the kinds above indicated, or of any other so-called high explosives, similar to them in character, in conjunction with a porous tamping, soaked with water (ordinary moss being a convenient material for the purpose), secures safety against explosions, not only under the circumstances above named, but also even if the shot thus loaded be fired as a blown-out shot in the presence of a highly explosive mixture of fire-damp and air. This mode of applying the violent explosives, besides ensuring safety under certain circumstances when the use of the water-cartridge may not afford perfect security, presents the additional advantages of simplicity and cheapness. The local, shattering, action of the violent explosives does not appear to be always modified by the employment of a tamping of water applied through the medium of a spongy solid, to the same extent as is the case with the water-cartridge, but gelatine-dynamite has been found to compete well with powder in some descriptions of coal when employed in conjunction with porous tamping and water. For blasting in roof or floor, or for working in stone-drifts, wherever fire-damp is liable to occur, the violent explosive agents, employed in conjunction with sponge-(moss)-and water-tamping may be said to leave nothing to be desired in regard to the combination of efficiency with safety.

3. Neither the water-cartridge nor water tamping, applied as above indicated, affords any security against explosions arising from the ignition of fire-damp, or of coal-dust and fire-damp combined, if employed in conjunction with *powder;* neither are they likely to do so in conjunction with any explosive agent analagous in its composition and mode of explosion to gunpowder.

MODE OF FIRING SHOTS.

The security, as regards protection against the dangers arising from fire-damp and coal dust, which can be obtained by the means above pointed out, is always liable to be diminished as long as the practice is pursued of employing as the means of firing shots, a fuze which is ignited either by application of a lamp-flame, or of a highly heated wire.

The firing of shots by electrical agency has for many years past been reduced to a very simple and safe operation, and one which now involves but trifling extra expenditure; and it is matter for great surprise that its employment should still be so limited. Very little instruction is needed to enable a man of ordinary intelligence to fix the electric fuze or detonator, to connect it with the conductors, and to go through the simple operations of connecting these with the firing instrument and firing the shot by means of it. One of your Commissioners, who has been much concerned in the development of this system of firing charges, has had very long experience connected with the subject of electric mine or shot-firing, and with practical work in mines and quarries, has never experienced any difficulty in speedily familiarizing the men with the simple necessary manipulations, and has always found this method of firing gladly taken up by them. Apart from the safety it secures, by dispensing with the employment of flame or a highly incandescent body for communicating fire to the fuse of the shot, it presents certain special advantages, which should contribute to secure its extensive employment under ground. One of the most important is that the firing of the shot is under the complete control of the operator, who determines its explosion at a safe distance and at any desired moment. If, therefore, any doubt arises at the last minute as to the safety of firing, the operation may be postponed for any period. There is, moreover, no possible risk of a permature firing of the shot before the operators may have retired to safe positions, while, if a shot fails to fire, it may be at once approached without any risk. Lastly, if, as is frequently the case, it would be desirable to bring the effects of several shots into operation at the same time, the absolutely simultaneous explosion of several shots by means of the usual electrical ex-

†In March 1881, Mr. W. Smethurst communicated to the Manchester Geological Society a paper "On Explosives used in Mining" which included a full description (illustrated by drawings) of Abel's water-cartridge, consisting of a long case filled with water by which the enclosed charge was completely surrounded. The mode of using it, the successful results obtained in getting coal, near Wigan, with dynamite-charges applied in the water-cartridge, and the experiments which had demonstrated the safety attained by its employment in the presence of fire-damp, were described in detail. The results dealt with were obtained in the autumn of 1880 in the Wigan 4-foot seam in Garswood Hall Colliery by Sir F. Abel with the assistance of Mr. Smethurst, whose description of the water-cartridge and the mode of firing it was published in "Iron" of March 18th, 1881; experiments were made with his water-cartridge in public by Sir F. Abel in that year, and a number of experiments were also made with it in Wales by Mr. Galloway for the Royal Commission between April and July, 1881. In March, 1882, a public lecture was delivered by Sir F. Abel at the Royal Institution of Great Britain, in which the water-cartridge was exhibited and its action explained, and an account of this lecture was published. In October, 1882, Mr. Miles Settle obtained provisional protection for "an improved form and construction of water-cartridge," the invention being described as consisting in completely surrounding the charge by water, in lieu of the cartridge "having water at but one end, or but partly around the charge, as hitherto." The Patent (No. 4,945) was completed in April, 1883. The cartridge as described in Mr. Settle's specification is identical in character with Abel's water cartridge as described and made public in March 1881, except that it contains diaphragms to support the charge in the center of the outer case or water-cartridge, a perfectly useless complication, as the water-cartridge acts in identically the same way, in whatever position the charge is in the outer case (even if lying against its side, or touching the bottom), provided this outer case be completely filled with water. The water-cartridge, in its original and most simple and efficient form, as devised by Sir F. Abel and used in the numerous experiments of the Royal Commission, is therefore public property, and may be freely used, in conjunction with any of the high explosives. Another patent has been taken out quite recently for the water-cartridge and the experiments witnessed by Mr. Sawyer were conducted by the patentees, but neither of these patents can in the least interfere with the free use by the public of the water-cartridge, which was publicly described and exhibited in 1881.

ploding appliances is effected with certainty by very simple modifications of the ordinary mode of connecting the fuse with the firing instrument.

For the foregoing reasons we consider that the combination of arrangements for firing by electricity with the use of the high explosives either with the water-cartridge or with the moss-and-water-tamping, is a matter which should receive the serious attention of managers of mines where recourse to these new modes of shot-firing is necessary, and where no special difficulties, such as may arise from a very wet condition of workings, may have to be encountered.

The employment of the ordinary miner's fuse or so-called safety fuse in coal-mines, is attended not unfrequently by a source of danger additional to that involved in the operation of lighting it; namely, by a liablity of flame or highly heated gases to burst through some place in the coating or envelope of the piece of fuse which protrudes from the shot-hole. With very carefully made and specially protected fuse this rarely occurs, but the additional cost, and also the additional diameter of such fuse, militate against its adoption. The present representatives of the original makers of the Brickford fuse have, however, recently given their serious attention to the production of a fuse of about the ordinary diameter, in the safety of which, when used in fiery mines, reliance can be placed, and their efforts appear to have been crowned with success; a simple modification of the ordinary fuse has been submitted to us by them, and has been tested with satisfactory results. Its cost is not likely to exceed that of the ordinary form of fuse.

A form of lamp has been constructed by Messrs. Johnson and Howat to be used for inflaming the fuse, when shots are to be fired in localities where fire-damp is liable to occur, and of thereby dispensing with the application of the naked flame to the fuse or with its ignition by a wire which is first thrust between the meshes of the lamp-gauze and thus raised to the requisite temperature. The same, no doubt, renders the application of flame to the fuse much less dangerous, but the arrangement is of a complicated nature.

Your Commissioners are of opinion that the provision of some simple combination of chemical and mechanical devices by which the fuse may be ignited without external application of flame or a red hot body, at any desired time within narrow limits, after it is set into action, should not be attended with any great practical difficulties; the employment of such an arrangement, which may also be made the means for preventing any lateral escape of fire from the short projection end of fuse, and of delaying the explosion of the charge for a definite period after ignition has been effected, would greatly reduce the risk of accidents attending the use of the ordinary mining fuse. They may add that this point is now receiving the active attention of one of them.

### SUBSTITUTES FOR EXPLOSIVE AGENTS IN THE BREAKING DOWN OF COAL AND STONE,

*Mechanical Appliances.*—During the last few years many contrivances have been brought forward for the purpose of obviating the use of powder in fiery collieries. It is well known that certain seams of coal may be hewn down with facility,* and that particular forms of work may be adopted in some seams which bring the pressure of the superposed strata to aid in the breaking down of the coal, but that other seams are so strong and resistant as to require very energetic means for dislodging the material even when undermined or holed. Furthermore, the taking down of stone over thin seams, for the indispensable enlargement of roadways and for the driving of cross measure or stone-drifts, needs, equally with the working of hard coals, a recourse to some contrivance less painfully laborious and slow than the common wedge and sledge hammer.

For the insertion, in suitable places in the seam, of some expanding appliance it is needful to bore holes of from 1½ to 4 inches diameter; the hand auger so long used for performing this operation is soft material has very generally given place to drills or perforators, worked by a ratchet bar or by a winch handle. These are mounted on a wrought-iron standard to be firmly wedged between roof and floor, and several modifications now exist capable of boring to the usual depth of holing, from 2 to 3 feet, in somewhat less or more than half an hour.* A long and taper steel wedge is introduced into the holes thus drilled, between two "feathers" or side clips, and is driven home by blows from a sledge-hammer or from a tup. The apparatus of Macdermott and of Dingley and Ackers, largely employed in our coal-fields for years past, belong to this class.

Very meritorous efforts were made twenty years ago to apply the hydraulic press to the forcing down of the coal. Mr. Chubb's press was applied by him to a range of pistons inside the hole, and by Messrs. Grafton Jones, and Bidder and Jones, to a long wedge, and these arrangements were employed on a large experimental scale at pits in South Wales and in the Potteries coalfield. The results appeared at first promising, but so far, they have not been attended by permanent success. Fresh experiments have, however, recently been made with another form of hydraulic apparatus, on the merits of which sufficient experience has not yet been obtained. On the other hand, some patent compound wedges have newly been brought forward in which a screw-bar is applied to the introduction of a wedge or wedges between cheek pieces or feathers. Some of these appeared to promise so well that we were glad to take advantage of the liberal offer of Mr. Mundy, to place at our disposal parts of his Shipley collieries for a comparative trial of several different methods of bringing down a very refractory coal, and even a roof-stone, without the use of explosives. Lengths of 40 yards of a long wall face, similarly holed or undercut to 3 feet deep, were allotted to each of four competitors, viz., Mr. W. F. Hall, Messrs. Asquith and Ormsby, Mr. Wood (Dingley and Ackers), and the Compressed Lime Company. These trials occupied two days (in July, 1884); the lime process took the first place in the coal getting, while Asquith's wedge ranked first in the breaking down or "ridding" of the roof-stone.‡

A most powerful and efficient apparatus for the purpose of driving in stone, where fire-damp is liable to be met with, is the *bossoyeuse* of Messrs. Dubois and Francois, which has now for some three years past been applied on a large practical scale at coal mines near Liège, and at Blanzy. The hole is bored by the well-known compressed-air borer of those engineers. A number of holes are grouped in a certain pattern in the face of the work, and then plug-and-feather wedges are successfully driven into the holes by a ram operated by the compressed air. The rock, weakened by the numerous boreholes, is thus burst in from one of them to another, and the rapidity with which a number of holes can be opened is stated to admit of this method contrasting favorably with the use of gunpowder even in point of expense. We examined with great interest the two examples of this apparatus on view at the International Health Exhibition of 1884, together with large samples of the rocks which have been driven through. The details given in the report of the progress and cost of the work thus executed confirm our opinion of the apparent efficiency of this system in places where compressed air is readily applicable.

Within a short time past a machine of an analogous description to English and Beaumont's tunnelling machine, which was employed at the Channel Tunnel, has been applied by Colonel Beaumont to the boring out of a stone drift of 7 feet 2 inches diameter in the coal measures at the Bridgewater Collieries. About 200 yards had been excavated in July, 1885, of which the portions executed in bind or indurated shale were successfully carried out, but where gritty stone came into view the strata presented much difficulty. The sparks given off from this latter on contact with a steel point or edge are abundant, and, in the event of an explosive gas-mixture presenting itself, would be a serious source of risk, as indeed would be the case also with the *bossoyeuse* above mentioned. It is sought to annul this danger by keeping a jet of water playing on the face, but it is very doubtful whether absolute reliance could be placed upon this expedient as a safeguard.

Mr. W. Walker has introduced a rotatory borer actuated by compressed air into some of the Cleveland mines. It is intended to be a substitute for manual labor with the jumper in preparing holes for charges of powder, and is reputed, where we have seen it working, to effect a great economy in time.

### COMPRESSED AIR CARTRIDGES.

The application of the force developed by the bursting of cartridges charged with highly compressed air, has been made the subject of practical experiments conducted at several collieries between 1879 and 1882, Mr. Ellis Lever having incurred considerable trouble and outlay in endeavoring to develop the application of a machine invented for this purpose by Mr. Samuel Marsh, of the Clifton Colliery, Nottingham. Although accounts of several experiments conducted therewith have reached us, we have not been able to discover that the process has been anywhere in regular work, and our attempts to witness its operation were not attended with success.

### LIME CARTRIDGES.

Attempts were made many years ago by Sir George Elliot and others to apply the rapid and considerable increase in volume of caustic lime, which occurs upon its union with water to form the hydrate (slaked lime), as a means of bringing down coal; no tangible success was, however, achieved in this direction until Messrs. Sebastian Smith and Moore, in 1881, made two important steps in advance in the utilization of this source of force:

(*a.*) By using nearly pure caustic lime in the form of cylinders or cartridges produced by high compression of the ground material, whereby the full capacity of a bore-hole is utilized without difficulty, while the lime is obtained in a form in which, when preserved with proper care, it is less liable to deteriorate than if kept under the same circumstances in the form of more or less porous or fissured lumps.

(*b.*) By utilizing the considerable heat, developed in the loaded hole by the rapid slaking throughout of the well-tamped charge of lime, for the gener-

*Carr and Urwin, Baird and Sons, Glasgow, and Wilson and Sons, Bishop Auckland, have brought out perforators of a more or less analogous kind.

‡ During the preparation of this report another apparatus for the same purpose has been brought out as the Patent Roller mining wedge, by Mr. Burnett, of Hartlepool.

ation and superheating of steam in somewhat considerable quantity, whereby an important addition is made to the force exerted by the expansion of the confined lime charge.

The method of applying the lime to the throwing out of coal has been elaborated in a simple and thoroughly efficient manner by Messrs. Smith and Moore, the arrangement for ensuring the simultaneous application of the water throughout the entire length of the charge or cartridge being a very important element in the success of the system. We availed ourselves, in July, 1884, of the invitation of Mr. Mundy to visit the Shipley Collieries, where the lime cartridges had been elaborated and had been in constant use in part of the workings since January, 1882, and we then witnessed the regular work coal of getting by lime in operation there. The efficiency of the system for working in a moderately hard coal free from fissures, was thoroughly demonstrated by that work. The proportion of failures due to the escape of the steam from unsound places traversing the bore-holes, or from imperfectly prepared shots, appeared to be very small; the preparation and charging of a considerable number of holes in the coal face were carried out with comparative expedition, and although the period which elapsed after the injection of water into the cartridge, before the charge began to operate, varied somewhat considerably, this did not appear to interfere with the efficient joint action of several holes which were watered in rapid succession. The charges did their work in most instances up to the end of the holes; the coal was brought down in very large masses, there being but very little small coal produced, and that chiefly by the fall of the coal when the sprags were removed from the undercutting. The freedom from danger to the men, who had only to retire to a short distance after removal of the sprags until the coal was brought down without any violence of action, was palpable. The comparative slowness of action of the charges (from 10 to 40 minutes) appeared to be in great measure compensated for by the fact that the men could return at once to their work when the coal had fallen, and the advantage in point of economy of the process over shot firing with powder, in coal of the character met with in the Shipley Collieries, appeared, from the data furnished to us, have been conclusively established.

It is noteworthy that the "deep hard" coal seam which is being regularly worked by means of lime cartridges at Shipley, is the same seam of which Mr. R. Harrison, of the adjoining Eastwood Collieries, said, in his evidence before us, that to work it without the use of explosives would be tantamount to shutting it up.

TO BE CONTINUED.

---

The price of Statistical Tables of American Water Works is Two Dollars: *free* copies will be sent only to advertisers, Water Works offices, to parties who give us information for future use, and to the press. The advanced demand will influence the edition somewhat; our aim is to comply with the terms of our contract with advertisers most thoroughly; the margin of profit to us is so small, however, that we do not care to lessen it with an unnecessarily large edition which is of little value as soon as a new edition is announced.

### Foote's Water Meter.

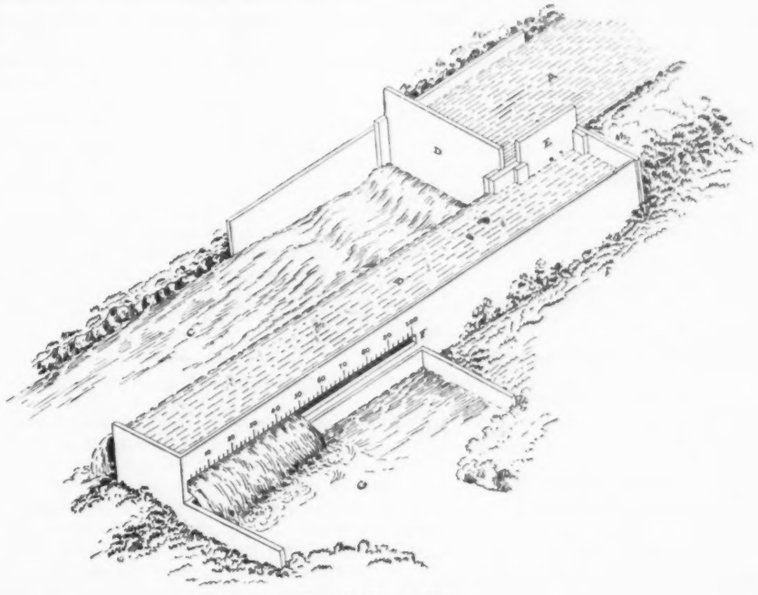
At the meeting of the American Society of Civil Engineers, held on October 6th, last, Mr. A. D. Foote, M. Am. Soc. C. E., presented a short paper describing a water meter designed by him.

Engineers connected with irrigation works have long felt the need of a cheap, practical and reasonably accurate method of measuring small volumes of flowing water as delivered to the irrigator. The practice of selling water by the area irrigated leads to waste and a continuous conflict between the consumers and the owner of the water supplied. The methods now in use are usually crude and very imperfect.

The annexed illustration simply shows the principle of the invention of Mr. Foote. Referring to the cut, *A* shows the main irrigation ditch with a regulating gate at *D*; *E* is the gate controlling the flow in the direction of any individual irrigator; *B* is a side flume with a short overflow in the direction of the main ditch; *F* is an opening, in this case, 100 inches long by 1 inch high, which has upon it a constant head of 6 inches as maintained by the overflow. This arrangement furnishes 100 "Miner's Inches" of water when open to its full extent; but an inside slide which can be locked, reduces the delivery to any required quantity under this maximum figure. *G* is the final delivery to the irrigated area. We might add for the benefit of some of our readers that a "Miner's Inch" of water is equivalent to the volume delivered, through an opening 1 inch square in a plank 2 inches thick, under a head of 6 inches of water to the upper edge of the opening.

In the plan proposed by Mr. Foote, the length of the weir can be prolonged to any extent desired and its accuracy increased. And the whole arrangement can be placed inside the main ditch, with simply a pipe through the bank to carry away the measured water, thus decreasing the danger from breaking banks or loss from leakage.

This meter certainly appears to us to be very simple, cheap, safe and sufficiently accurate for the purpose intended.



Foote's Water Meter.

### Progress on the Forth Bridge.

The accompanying sketch illustrates a rather neat plan for showing the progress on the Forth Bridge to October 15, as seen from North Queensferry. We reproduce it from the Dundee *Advertiser*, of the date given. The central and the Fife piers are practically in an almost equally advanced condition with the one pictured.

Referring to the cut, the dotted lines show the ultimate height of the approach viaduct and the finished outlines of the cantilever and pier members. As before described by us the approach viaduct is being lifted bodily by hydraulic power and the piers built up as the truss is raised. The working platform shown on the pier rests upon heavy hydraulic rams located in the four main posts and is lifted by them as the work of placing and riveting the plates progresses. This platform carries the travellers and hoisting machinery for manipulating the various parts of the huge tubes. The cylinders indicated around several of the pier posts and struts are nothing more than light wrought-iron frames covered with canvas for the better protection of the riveters; they are movable cages, in fact, being lifted with the platform.

The Forth Bridge from Queensferry; Oct. 15th, 1886.

The main lifting girders of the platform, two in number, pass *through* the four main posts, and rest on the rams as described; on these girders rest four others running with the axis of the bridge and located one on each side of the main posts. The total weight of this platform, including necessary machinery, will be about 400 tons.

# ENGINEERING NEWS

AND

AMERICAN CONTRACT JOURNAL.

TRIBUNE BUILDING, - NEW YORK CITY.

THE ENGINEERING NEWS PUBLISHING CO. PROPRIETOR.

VOL. XVI. Saturday, November 13, 1886.

CONDUCTED BY

GEO. H. FROST, - - - Assoc. Am. Soc. C. E.
D. McN. STAUFFER M.Am.Soc.C.E.: M.Inst.C.E.

PHILADELPHIA OFFICE.
504 WALNUT ST.
W. M. PATTON, Manager.
Authorized representative for Pennsylvania, New Jersey and Delaware. Advertising rates made known on application.

CHICAGO OFFICE.
115 DEARBORN ST., ROOM 85,
EDWARD EDGERTON, Manager.

TERMS OF SUBSCRIPTION.

TO U. S. AND CANADA.

| | |
|---|---|
| One Year | $5.00 |
| Six Months | 2.50 |
| Three Months | 1.50 |
| Single Copies | 12 cts. |

OTHER COUNTRIES.

Add Postage 3 cents for each number.


MAGAZINE RENEWALS.

The *Century Magazine* closes its yearly volume with the *October Number*. Renewals are in order for November. The price to ENGINEERING NEWS subscribers and their friends is $3.55; with ENGINEERING NEWS, $3.55. The new *Scribner's Magazine* will be out December 1, and we will make liberal terms to subscribers. *Harper's Monthly* is renewable on December 1 Orders ought to be sent in in November to save the publishers trouble.

TABLE OF CONTENTS.


| | PAGE |
|---|---|
| The Large Retaining Walls of Cournion, La Bastide, La Forst, and Cerbere | 305 |
| Engineers' Surveying Instruments (*Illustrated*) | 305 |
| Accidents in Mines | 307 |
| Foote's Water Meter | 311 |
| Progress on the Forth Bridge | 311 |
| Editorial Notes | 313 |
| American and English Railroads | 312 |
| Russian vs. American Petroleum | 313 |
| On the Performance of Stationary Steam Engines | 313 |
| The Thilmany Process for Preserving Wood | 313 |
| New York Department of Public Works | 314 |
| Wanted: Two Creeks | 314 |
| Montreal City Report | 314 |
| Sanitary Wants | 317 |
| Powdered Anthracite and Gas Fuel | 314 |
| Brooklyn Bridge Report | 315 |
| The Value of Time a Century Ago | 315 |
| New Titles for Engineers | 315 |
| Personal | 315 |
| Liverpool Engineering Society | 316 |
| Correspondence | 316 |
| German Specifications for Standard Portland Cement Tests | 316 |
| Ontario & Quebec Railway Bridges | 317 |
| Water | 317 |
| News of the Week | 318 |
| Market Summary | 320 |
| Building Items | 320 |
| Statistical Tables of American Water-Works | 329 |


MORE rapid-transit is a thing of very near future. The manager of the elevated system reports an average daily addition of about 200,000 passengers as the practical result of reduced fares. At the present rate of travel, and there is no reason to suppose it will decrease; the elevated railways will carry 175 million passengers in the present fiscal year, or 70 million more than in 1885. The projected feeders, connecting with the ferries on the east and west sides of the city, are likely to swell the traffic. The maximum carrying capacity of the present system is being approached rapidly.

As a continuation of our editorial "The Late Yacht Races," we mention that Mr. Byrne, the English yacht designer, says, "I don't think it is possible to build a yacht according to the English plan, able to beat the Mayflower."

Yet there are many men who think our skill as marine architects is a thing of the past.

IN answer to a suggestion that American locomotives be sent to the Newcastle (England) Exhibition next year, and that an attempt be made beforehand to secure their purchase by an English road, our contemporary *The Mechanical World* has a word of warning to American builders.

That journal thinks that an American passenger engine might safely pass over the English roads, but has doubts about the "Consolidation" type. It says that when in 1880 the first consolidation engine was set to work in New South Wales, an engine fitted with a template representing the cross section of the new engine was first run over the road, and as a result there was much hewing of masonry and sawing of timbers at station yards and platforms.

American and English Railroads.

The *Mechanical World*, of Manchester, England, that some time since took exceptions to our statement that there are not in all England 439 miles of road in as good line and surface as are found on the Pennsylvania road, between Jersey City and Pittsburg, has accepted our invitation to carefully read Mr. Dorsey's paper, showing the superior economy of our practice in spite of the fact that our wages are almost double their's on an average, and though it judiciously abstains from any entanglement with Table No. 45, to which its attention was particularly solicited, both our article and Mr. Dorsey's paper are discussed with an evident desire to afford each fair treatment.

Our contemporary reiterates its view that English tracks are in better order than ours, but it is doubtful if any certainty can be arrived at as to which is right without sending over a Dudley dynograph car, such as has been used in this country, with its record. The cost of maintenance of way per passenger or ton mile is given by Mr. Dorsey as .206 of a cent on the London & North Western and .1 of a cent on the Pennsylvania, and the cost of motive power on the two roads as .266 and .174 of a cent, respectively, making the excess of cost of the combined maintenance of way and motive power, .225 of a cent for the London & North Western. It is submitted that if the track of the Pennsylvania road is not better than that of the London & North Western, there must be something miraculous about the Pennsylvania's rolling stock.

It is, however, freely admitted that we have some roads which are much rougher than any in England, possibly than any others in the world. In spite of this, and the fact that our trains average twice as much paying tonnage as the English, there is no doubt that our locomotives make on an average about 24 per cent. greater annual mileage than the English on roads of easier grades and curves, that in general are better surfaced than ours, and Mr. Dorsey's paper shows that the cost of locomotive repairs and renewals *per train* mile is, on the average, in favor of the American locomotive. It will be remembered that although many of Mr. Dorsey's tables and deductions have been published in *Engineering*, and either printed or referred to in all American engineering journals, their accuracy have never yet been questioned in any known publication.

Under these circumstances, it does not seem to us that the *Mechanical World* is working in the direction of progress when after advising the use of steel in locomotive construction, as a possible element of economy, it says:

"Assuming this to be done, however, there is not much further saving to be made. On the level and straight lines of this country, it is questionable if the extra cost of bogie trucks to locomotives is worth incurring, but we believe a great saving might be made by a better construction of vehicle."

We have already urged that a machine which is good on a rough track, will not pound itself to pieces on a good one, in spite of Sir Charles Douglas Fox's opinion to the contrary, and though in certain states of the American locomotive market, engines are doubtless higher priced here than in England, as in the case cited by our contemporary, on the average the American locomotive, as shown by the statistics of both countries, and by the foreign and "colonial" demand, is the superior instrument of transportation as well as the cheapest. This is shown by the fact that all the roads in Canada, though built with British capital, are now equipped with American locomotives or English locomotives that have been altered to conform to the American type. And we think ourselves justified in restating our opinion that the London & North Western could save money by throwing away its 2,476 locomotives and purchasing 550 of an *efficiency* equal to that of the average American engine, notwithstanding our contemporary's objections to the use of the word efficiency.

The point that it would be difficult for 550 locomotives "to head at one and the same time, say 1,200 trains," involves a question as to the necessity for 1,200 trains at one and the same time. We think that number no more necessary or even expedient than the costly copper fire boxes and brass tubes used in English locomotives, or the phenomenally high freight rates paid by British manufacturers to men who are, to use the words of our contemporary, "throttling commercial enterprise." Mr. Dorsey gives the aggregate daily trains over the entire line of London & North Western (1,811 miles) as 68 over the Pennsylvania (1,471 miles), as 45 and the average load of all trains in tons, or passengers as, for the London & North Western, 58, Pennsylvania, 160, and the products of these figures are 3,944 and 7,200 respectively.

There can be no necessity for the small freight trains one everywhere sees in England, and the American practice of large trains should be at once adopted. A *convenience* accompanied by a slightly increased traffic, doubtless accrues from frequent passenger trains, but the investigations of Mr. Wright when Labor Commissioner of Massachusetts, show that the average wages in England are only 60 per cent. of those paid in this country, and there is a still greater difference between the compensations of those who receive "salaries," excepting only the few heads of departments. The profits of manufacturing are probably greater there than here, but the few of these two classes can form but a fraction of a percentage of those who travel, and there is no corresponding advantage to offset the expense of frequent trains to save time that is earning so little money, when we are satisfied with less frequent service.

Many Englishmen have an idea, drawn from their inner consciousness, and consequently adhered to with pertinacity, that there is a loss of time from our end doors in what they are pleased to call omnibus cars; as, "The work of the Metropolitan Line, for example, could not be conducted without side-door cars. Two end doors would be wholly inadequate

to allow the rapid ingress and egress which are absolutely necessary if the service must be conducted." On this we quote from Mr. Dorsey's remarks at the discussion of his paper (not yet printed by the Society) endorsing his views as to the time lost at English stations on account of the small compartments and the consequent difficulty of finding seats.

In answer to the remarks about the comparative speed and facility of loading and unloading the American and English passenger cars, I took the time of 531 stoppages on trains running into and in London, and 342 stoppages on trains on the four elevated railroads in New York; in all cases, all stoppages that were prolonged by block signals, loading baggage or other causes, not caused by loading or unloading passengers were rejected. The average of the 531 London stoppages was thirty-three and one-third seconds, the average of the 342 New York stoppage was eleven and two-thirds seconds—nearly one-third.

On the London roads the shortest average stoppages were made on the Metropolitan Railway—theoretically eight or ten persons should be able to leave or enter a car by one door quicker than fifty persons can by two doors, practically it is not so, as much time is lost by the passengers in finding among the six kinds of carriages on the London trains, the particular kind he or she wishes to ride in. After this is found much more time is lost in opening doors and looking for a seat, whilst in the American cars there is only one class or kind—the passengers can enter by any door, and find seats after the train is in motion.

The statistics seem to show that end door cars of the omnibus type could conduct the traffic of the Metropolitan (underground) Line and they are practicable, even if the present division of passengers into three classes is retained. It is pleasant to again notice the very fair spirit in which the article under consideration is written, as it is only by fair and frank discussion that English railroad managers can be forced to "devote more time in attending to the details of the business they profess to understand," and any investigation pursued with a view to arriving at the facts would show the wasteful inferiorty of English rolling stock and railroad management.

### Russian vs. American Petroleum.

The news from the petroleum districts of the Caspian Sea is not encouraging to producers in this country. The latest report states that a well owned by Tagieff & Co. is spouting at the rate of 2,750,000 gallons per day with a jet 224 feet high. This seems almost incredible; yet in 1883, the Droojba well in the same region yielded for forty-three days a daily average of 850,000 gallons, and in 115 days a total of more than 55,000,000 gallons.

For want of transportation facilities, the product of this last "spouter" is wasting in the neighboring sands, but it is an indication of what might happen to our own market, were the Russians to succeed in building the proposed 600 mile pipe-line to the Black Sea referred to in our last issue. With oil at two cents per gallon at the well, piped to the seaboard for one cent more and transported in tank-ships to London for an additional two cents, we see a formidable rival to foreign trade looming up over the distant Caspian horizon.

As yet our export trade is not falling off, as the volume had increased from 204,000,000 gallons in 1876 to 367,000,000 in 1880; in 1881 it fell to 332,000,000, but rose in the next year to 483,000,000; and in 1883, 1884, 1885, it was 419,415 and 458 million gallons respectively. The foregoing statistics are for illuminating oil only, while we sent abroad in addition thereto in 1886 80,000,000 gallons of crude oil. At present rates of export the current fiscal year will show a total of 535,000,000 gallons. The value of this trade last year was $50,000,000, with American refined oil at American ports at six and three-fourths cents per gallon.

### On the Performance of Stationary Steam Engines.

Mr. George H. Barrus presents the following figures of feed-water or steam consumption for the type of unjacketed factory engines most commonly used in this country, having cylinders exceeding 20 inches in diameter, supplied with dry but not superheated steam. The figures given, which also apply quite closely to engines whose cylinders range from 14 to 20 inches in diameter, represent first-class practice. Dividing the figures in column 3 by 9, the approximate coal consumption per indicated horse power per hour is obtained.

*Feed Water Consumption for Non-Condensing Engines.*

| At 10 per cent. cut-off. | | | At 20 per cent. cut-off. | | |
|---|---|---|---|---|---|
| Initial Pressure of Steam above Atmosphere. | Mean Effective Pressure. | Feed Water Consumed per Indicated Horse Power per Hour. | Initial Pressure of Steam above Atmosphere. | Mean Effective Pressure. | Feed Water Consumed per Indicated Horse Power per Hour. |
| P'nds. per sq. inch. | Pounds per sq. inch. | Pounds. | Pounds per sq. inch. | Pounds per sq. inch. | Pounds. |
| 40 | 1·32 | 153·24 | 40 | 10·22 | 38·13 |
| 50 | 5·01 | 52·52 | 50 | 15·67 | 30·98 |
| 60 | 8·70 | 37·16 | 60 | 21·12 | 27·55 |
| 70 | 12·39 | 30·99 | 70 | 26·57 | 25·14 |
| 80 | 16·07 | 27·61 | 80 | 32·02 | 24·04 |
| 90 | 19·76 | 25·43 | 90 | 37·47 | 23·00 |
| 100 | 23·45 | 23·90 | 100 | 42·92 | 22·25 |
| At 30 per cent. cut-off. | | | At 40 per cent. cut-off. | | |
| 40 | 16·95 | 33·52 | 40 | 22·24 | 32·79 |
| 50 | 23·71 | 29·35 | 50 | 29·99 | 29·72 |
| 60 | 30·47 | 27·24 | 60 | 37·75 | 27·92 |
| 70 | 37·21 | 25·76 | 70 | 45·50 | 26·66 |
| 80 | 43·97 | 24·71 | 80 | 53·25 | 25·76 |
| 90 | 50·73 | 23·91 | 90 | 61·01 | 25·03 |
| 100 | 57·49 | 23·27 | 100 | 68·76 | 24·47 |
| At 50 per cent. cut-off. | | | | | |
| 40 | 26·40 | 33·16 | | | |
| 50 | 34·91 | 30·53 | | | |
| 60 | 43·42 | 28·94 | | | |
| 70 | 51·94 | 27·79 | | | |
| 80 | 60·44 | 26·99 | | | |
| 90 | 68·96 | 26·32 | | | |
| 100 | 77·48 | 25·78 | | | |

*Feed Water Consumption for Condensing Engines.*

| At 5 per cent. cut-off. | | | At 10 per cent cut-off. | | |
|---|---|---|---|---|---|
| Initial Pressure of Steam above Atmosphere. | Mean Effective Pressure. | Feed Water Consumed per Indicated Horse Power per Hour. | Initial Pressure of Steam above Atmosphere. | Mean Effective Pressure. | Feed Water Consumed per Indicated Horse Power per Hour. |
| P'nds per sq. inch. | Pounds per sq. inch. | Pounds. | Pounds per sq. inch. | Pounds per sq. inch. | Pounds. |
| 40 | 9·34 | 18·99 | 40 | 14·96 | 18·25 |
| 50 | 11·88 | 18·51 | 50 | 18·65 | 17·91 |
| 60 | 14·42 | 18·22 | 60 | 22·34 | 17·68 |
| 70 | 16·96 | 17·98 | 70 | 26·03 | 17·47 |
| 80 | 19·50 | 17·76 | 80 | 29·72 | 17·30 |
| 90 | 22·04 | 17·57 | 90 | 33·41 | 17·15 |
| 100 | 24·58 | 17·41 | 100 | 37·10 | 17·02 |
| At 15 per cent. cut-off. | | | At 20 per cent. cut-off. | | |
| 40 | 19·72 | 18·41 | 40 | 23·83 | 19·00 |
| 50 | 24·36 | 18·11 | 50 | 29·28 | 18·74 |
| 60 | 29·00 | 17·93 | 60 | 34·73 | 18·58 |
| 70 | 33·65 | 17·75 | 70 | 40·18 | 18·40 |
| 80 | 38·28 | 17·60 | 80 | 45·63 | 18·27 |
| 90 | 42·92 | 17·45 | 90 | 51·08 | 18·14 |
| 100 | 47·56 | 17·32 | 100 | 56·53 | 18·02 |
| At 30 per cent. cut-off. | | | At 40 per cent. cut-off. | | |
| 40 | 30·54 | 20·57 | 40 | 35·84 | 21·94 |
| 50 | 37·30 | 20·35 | 50 | 43·59 | 21·76 |
| 60 | 44·05 | 20·19 | 60 | 51·35 | 21·63 |
| 70 | 50·81 | 20·04 | 70 | 59·10 | 21·49 |
| 80 | 57·57 | 19·91 | 80 | 66·85 | 21·36 |
| 90 | 64·32 | 19·78 | 90 | 74·60 | 21·24 |
| 100 | 71·08 | 19·67 | 100 | 82·36 | 21·13 |

If the record in any special case does not fairly approach that given in the tables, it will be found advisable to have the steam plant thoroughly examined, with the view of locating the source of trouble.

There are still many old-fashioned engines in use, working under conditions very unfavorable to economy, whose speedy substitution by more modern and improved automatic cut-off engines will prove a fine investment and the only remedy to secure a decided and desirable saving in the power expense account.

Economy of feed water and of fuel are, of course, not the only things to be considered in the choice of a steam engine. For that matter, true economy is to obtain the horse-power, not for the least cost of steam or fuel, but for the least current money expense, the items of interest, depreciation, etc., of plant and other current costs of the motive power also coming in for their legitimate share of attention, as well as does the cost of fuel. Viewed from this correct stand-point of economy, it will be found, with the steam pressures now in current use (say in the neighborhood of 80 pounds per square inch above atmosphere) and with anthracite coal, at an expense of about $5 per ton, that in selecting an engine, the cylinder proportions, etc., should be such, that, if non-condensing, the engine will develop the required horse-power with a cut-off of about one-quarter, and if condensing, the engine will develop the desired horse-power with a cut-off of about one-sixth. Engines developing the average horse-power with these cut-offs, admit of a considerable increase of horse-power, if this should become necessary and advisable in course of time.

Close regulative capacity of engine is a consideration frequently of an importance scarcely second to that of economy, especially in mill practice, where, according to varying character of work and the number of machines in operation, the amount of power demanded and given out by the engine, must differ greatly and suddenly at short intervals. It is important in such a case, in order to secure uniformity in grade and quality of product, that the speed of revolution of engine, which directly affects speed of revolution of shafting and the speed of looms or other fabrication machines, should be practically the same, irrespective of variation in power demand.

In electric lighting, even a greater smoothness and regularity of action are demanded to ensure stability in production of electric current and steadiness of light. In the last few years the principal efforts at advance and the main progress recorded have been in the securing of this desirable steadiness of motion and close regulative quality of steam engines, without sacrifice of economy of fuel, and without excessive first cost. The success in this particular has certainly been gratifying.

### The Thilmany Process for Preserving Wood.

Many of our readers will remember a spicy and not entirely respectful letter from James H. Young, the President of the American Wood Preserving Company, to the Secretary of the Navy, which was published a year ago last August in pamphlet form, in which the president answered the report of a board appointed by the secretary to investigate the purchase of the Wood Preserving Company's plant by the Government.

The Board after making an *ex parte* examination, reported in effect that the Thilmany process did not either cause the copper or barium solutions to penetrate the wood throughout, nor did the known chemical reaction resulting from the contact of the sulphate of copper and chloride of barium actually take place in the wood to an extent sufficient to effect the desired object. Mr. Young contending that instead of examining the wood treated by the company, then in stock in the yard, they had confined their examinations entirely to specimens unskillfully and inefficiently treated under their directions, they having put eighteen different kinds of timber into the cylinder at one time for treatment, one piece being a white oak stick

30 feet long, 20 by 24 inches, which had lain in the navy yard for forty years.

Though the Wood Preserving Company apparently had sold their plant to the Government before the report under consideration was made, the president of the company has not given up interest in the reputation of the process, for we find in the *Army and Navy Journal* of October 30th, a correspondence between himself and sundry officials of the navy, from which it seems that four oak planks which had been preserved by the Thilmany process and were placed in the "Trenton" some ten years ago were lately bored in the presence of naval constructors, Much and Boush, and found to be "perfectly sound."

In this connection it might be of interest to know how far the report made at the Deer Park meeting by the Committee of the American Society of Civil Engineers on the Preservation of Timber, was influenced by the investigations of the Secretary's experts.

### New York Department of Public Works.

An abstract of the report of Gen. Newton, Commissioner of Public Works of the City of New York, is given as follows for the quarter year ending September 30.

The chief engineer of the Croton Aqueduct reports there were only seventeen days in the last three months when the natural flow of the Croton river was sufficient to supply the aqueduct to its full capacity. To meet this deficiency 3,300 million gallons of water were drawn from the storage reservoirs. The deficiency in the Bronx river flow was even greater, as compared with the normal flow; and 1,000 million gallons of water were drawn from Kensico and Rye Ponds reservoirs. An average daily supply of 15 million gallons was received through the Bronx river conduit. The maximum rainfall in the three months was 12.47 inches recorded at Croton Dam; the minimum was 5.69 inches at the Central Park reservoir.

The use and waste of water continues, despite the short supply, and the Aqueduct and Bronx river conduit have been taxed to their full capacity. But the excess of consumption over supply has reduced the depth by 24 inches in the city reservoirs since August 15, equal to 60 millions of gallons. The Commissioner suggests that the only way to meet the present problem is to grant the Department the necessary means and authority to control the use of water and reduce the consumption per capita. To this end the water-meter system should be extended as rapidly as possible. The total of meters now in use is 14,330; 130 having been placed in the quarter.

Under the head of "Repairing Fifth Avenue" the commissioner says that work thereon was suspended on September 16, shortly after the publication of Col. George T. Balch's report to the Commissioner of Accounts, alleging certain defects in the carrying out of the contract by the contractor. Work was ordered to be resumed on September 25, but to the date of the report (October, 13) the contractor had not resumed work. In a letter of October 2, the contractor stated that he declined to go on until paid for work already done, and he demanded the proper certificate of the Department. In accordance with the recommendation of the Corporation Counsel the matter in dispute was left to two disinterested civil engineers and was so left at the date of report. (These engineers have since approved the work under the terms of the contract.)

The present extent of the sewerage on Manhattan Island is 412.7 miles with 5,054 receiving basins. This Department has charge of 27¾ miles of macadam roadway covering an area of 958,638 square yards, and about forty miles of unpaved streets and country roads. The macadam roads, built years ago as suburban pleasure drives, are now subjected to heavy travel and promise to become a nuisance unless more labor and material is expended upon them in the future.

On October 1, there were 23,908 gas lamps, 711 electric lights and 120 naptha lamps in use in the city.

### Wanted: Two Creeks.

A rather severe commentary on the favorite Congressional method of distributing the public money under the River and Harbor Bill, is seen in the following:—

Congressman D. Wyatt Aiken, of South Carolina, furnishes for publication a letter received from First Lieut. Frederic V. Abbot, U. S. Engineers, in reference to the act for the "improvement of rivers and harbors," as passed August 5, 1886. Under this act Lieut. Abbot says he was required to make an examination, with a view to improvement, of Clark's Creek, and Mingo Creek, S. C. But he further says that "after careful search I have been unable to determine satisfactorily the location of these creeks," and he requests Congressman Aiken to kindly furnish him with the information necessary for the execution of his orders.

In justice to Mr. Aiken, we should say that these "lost creeks" are not in his district, and he denies having any knowledge of them in any form. Comment is unnecessary.

### Montreal City Report.

In the last report of Mr. Percival W. St. George, City Surveyor of Montreal, Canada, there is described a new form of pine sidewalk which, it is claimed, is easily laid and very good for the purpose intended. It is made of 3 × 4 inch pine set with the 4 inch side vertical; a groove in the sides takes a ½ × 1½ inch tongue entering three-quarters of an inch into each plank. Mr. St. George, however, while commending it as a wooden sidewalk, recommends that it be speedily replaced by either flagstone, cement, asphalt or wooden blocks, either of which would be cheaper and more healthy.

In the same report the total snow-fall for 1885, is given as 177.6 inches; the average for the last eleven years was 122.1 inches. Snow removal is an important item in the city expenses of Montreal, and the present report illustrates snow ploughs for cutting the snow-banks on the sides of the street and spreading them over the center, and a snow-planer to level the snow on each side of a beaten horse track. The cost of removing the snow in 1885 was somewhat over $20,000.

The sewerage of Montreal is receiving more attention than in years past; 32,622 feet of lateral sewers were built in 1884-85; 10.6 miles have been built since 1878, making the present total mileage of sewers in the city 90 miles. The construction of an upper level intercepting sewer is earnestly recommended to relieve the flooding of certain low districts by reason of the inefficiency of existing sewers. The sewer as projected would drain about 944 acres and its total cost is estimated at $110,000. Better street paving than the present macadam is also recommended.

### Sanitary Wants.

Capt. Douglas Galton, in an address before the Sanitary Institute of Great Britain lately, calls attention to several very important but neglected items in the present search after material improvement in public health. His remarks will apply here as well as in England.

The first neglected point is that the study of sanitary science is not made an integral part of the education of children. Then legislation is defective; sanitary areas are arbitrarily fixed and need adjusting. The supervision over rivers is inadequate; and while the density of populations leads to pollution of our rivers, no satisfactory steps are taken to prevent this pollution. Floods should be prevented as they lead to sickness and low health. And people should be taught that house drainage is just as important to the sanitation of towns as the town sewerage.

The third and an important point made by Capt. Galton is the necessity for trained sanitary advisers in practical sanitation. He very properly classes as a fallacy the too prevalent idea that any engineer, whether he has studied sanitary science or not, is qualified to have charge of the sanitation of a town; and that any person, whatever his previous occupation, will do for a sanitary inspector or inspector of nuisances.

The last point is that we are all too careless in not arresting infectious disease at its first appearance. Due notice should be given of such disease and the case should be isolated effectively. Capt. Galton illustrated his points made by citations from existing cases in England.

### Powdered Anthracite and Gas Fuel.

In the report for 1886 of the Scranton Board of Trade the use of pulverized coal or gas as a fuel is treated at length. We make the following abstract:—

Commencing by showing the rapid growth of the yearly output of anthracite coal (from 365 tons in 1820 to 31,623,529 tons in 1885), and the phenomenal increase of the horse-power of machinery, the report points out the need of improvement in the methods of combustion which are as yet wasteful in the extreme, "from 75 to 90 per cent. being absolutely lost in the general utilization of coal of any kind." Mechanical grates, inclosed fire chambers and revertible flues have effected a partial saving.

But the first important step made in the direction of economy is in the mechanical preparation of the fuel by reducing it to an impalpable powder, so fine that it will float in the air like smoke, or be made up of about 125 million particles to the cubic inch.

The "Whelpley and Storer" process as it is called, is the first intimation of success in this line, and seems to solve the problem of the utilization of the vast hills of coal waste or culm in the coal regions. Mr. H. M. Chance, of the Second Geological Survey of Pennsylvania, states that at a trial of this process at the National Armory, at Springfield, Mass., an economy of 60 per cent. over old methods of heating was effected by the use of pulverized anthracite.

As explained by Mr. Chance the secret of this process lies in the fact that while a pound of coal will give an equal amount of *heat*, whether burned quickly or slowly, the *temperature* of the flame and gases depends entirely upon the manner of combustion. This is illustrated by a block of wood which may be consumed and but slightly increase the temperature of the fire-place; but if this same block is made into shavings it will burn with extreme rapidity and a corresponding increase of temperature. The amount of heat in each case is the same, but one is made effective by being generated in less time. The machinery used in the process referred to has been frequently described, but the success of the matter depends upon:

*First.* Simple and efficient machinery to reduce the coal to dust at a very small cost.

*Second.* Reduction of the coal to floated dust.

*Third.* Automatic supply of coal and air each capable of being regulated at will.

*Fourth.* The reduction of the coal and the simultaneous feeding of it with air into the fire-box by the same machine.

*Fifth.* The intimate mixture of the fine particles of coal dust with air, so that each particle shall be surrounded as it enters the fire-box by air sufficient for its combustion.

The first economy lies in the cheapness of this fuel as compared with lump and grate fuel. Anthracite and bituminous waste or culm can be used and the saving approximates two or three dollars per ton. 2. The rapid and complete combustion of the comminuted coal will evaporate one-third more water in a given time, or two pounds of dust fuel will do the work of four pounds of lump coal burned in the usual way. No smoke, sparks or cinders arise from burning this comminuted coal, the combustion is complete. 3. No brick stacks are necessary to increase draught and carry off the smoke. A cheap and simple sheet-iron chimney is sufficient. 4. In using dust fuel for generating steam, etc., no grate bars are required, and that constant source of annoyance, expense and delay is avoided. 5. The feeding of this fuel being regular and through a feed pipe, no opening of fire-doors is required and steam can be maintained at a uniform pressure. 6. The dust-fuel is fed automatically, and one man can easily attend to ten boilers with more comfort than in the old method. 7. The saving in lost space in transportation on ocean and lake steamers is an item that can be utilized for profit in extra space for freight.

This process has been in use in the Springfield Armory for over five years with marked success, and has been reported upon by C. E. Emery, C. E., who says the process "consists substantially in blowing pulverized bituminous and anthracite coal over a small fire. The pulverized fuel ignites in the furnace like gas and burns with an intense heat." The pulversizing machinery is simple and the feed is automatic and adjustible.

The report regards gas as the future fuel, and as anthracite coal combines the largest percentage of carbon, 80 to 94 per cent.—it will lead even natural gas in cheapness and effectiveness. To illustrate this claim, the following comparative table of the utilization of fuel in mass and as a gas is given:

| | Percentage of Heat Utilized. | |
|---|---|---|
| | One lb., Coal. | Gas from one lb., Coal. |
| Crucible Furnace | 3½ | 90 |
| Large Blast Furnace | 36 | 90 |
| Domestic Use. | 10 | 90 |
| | Available | Heat. |
| Crucible Furnace | 4⅝ | 7,246 |
| Large Blast Furnace | 4,680 | 7,246 |
| Domestic Use. | 1,300 | 7,246 |

The report states that natural gas has forced the issue, but regards this as a limited or sectional product, "fitful, and of doubtful dependence." Solid fuel as now consumed is accompanied by wasteful extravagance, as testified to by Siemens, Rankin, Galloway, Grouven an others; the loss of the products of combustive being put at from 70 to 90 per cent. The report intimates that the time may come when the coal will be converted into gas in the anthracite fields and conveyed by pipes to the consumers.

Water-gas fuel, or the practical conversion of water into hydrogen and oxygen, is regarded as the first great forward movement in gaseous fuel. Prof. T. S. C. Lowe claims that he can produce from one ton of coal, from 50,000 to 100,000 cubic feet of gas, with 80,000 feet as probably a fair average; at present market rates for coal and with a liberal allowance for plant and labor, this would make the gas cost about nine cents per 1,000 cubic feet. The specific gravity of the fuel water-gas was determined by Dr. Ward to be 552 (air=1) at a temperature of 62° F. Therefore 1,000 cubic feet would weigh 42.01 pounds. Theoretical yield of 100 pounds of pure anthracite is stated to be 228.22 pounds of pure gaseous products—the figures claimed would be 66⅔ per cent. of the theoretical yield. This would leave 33⅓ per cent. to provide for the consumption of coal for heating the generator for the production of steam, and for impurities of the coal.

Producer gas fuel is next referred to with a brief sketch of its history since 1846. Combined hydrogen and carbonic oxide gas follows with the concluding statement that by this process 100,000 cubic feet of gas can be made from a net ton of coal or culm.

Figuring on gas as produced at the mine the report puts the cost of production as follows:

| | |
|---|---|
| One ton of waste at producer | $0.50 |
| Labor handling same per ton | 0.30 |
| Expenses of plant per ton | 1.00 |
| Total cost of 100,000 cubic feet of gas = | $1.80 |

or less than *two cents per* 1,000 *cubic feet.*

The report goes at considerable length into the question of natural gas and its probable duration; and finally concludes from the numerous authorities quoted that its duration is limited in any particular section. In referring to the mechanical difficulties connected with natural gas, it states it is impracticable to pipe it over thirty miles, and at twenty miles the pressure will fall from 80 to 90 per cent.

In regard to the quantity of culm or coal waste available for fuel, its volume can only be guessed at. It lies in mountain piles containing many millions of tons and can be had for the taking. It is estimated that 20,000,000 tons of this culm are valuable fuel, and this is being added to at the rate of 2,000,000 tons per annum. Converted, into gas, this culm pile would represent 2,000,000 million cubic feet of fuel.

## Brooklyn Bridge Report.

At the last meeting of the Brooklyn Bridge Trustees a report was made covering the expenditures, etc., from August 1, 1881 to November 1, 1886. In this period $755,511.86 had been paid out, this amount being chiefly made up of the following items: $280,000 to the city of Brooklyn, $140,000 to the city of New York, $74,250 for real estate in Brooklyn, $37,750 for new cars, $12,150 for new locomotives, $3,300 for boilers, $4,000 on account of new driving engines, $5,500 for paving and flagging, $10,639.75 for supplementary stairs in Brooklyn and $1875.12 for same in New York, $19,574.25 for Chatham street extension and $16,125.90 for High street extension, $142,952.75 for New York warehouses, etc. Of the total $590,462 was paid from income account and the remainder from the construction account. The statement shows that the bridge would receive as the total rental of its warehouses and real estate, $77,317 per annum.

For October, the receipts from the promenade were $1,901.50 a slight increase over the same month last year; for the carriage-way, $6,083.18, an increase of $510.41, and from the railroad, $63,885.01, an increase of $10,016.01 over October, 1885. The number of passengers using the promenade was 311,045 in the month, with 2,317,392 carried on the railroad, making a total of 2,628,437.

The Executive Committee sustains the Superintendent and Chief Engineer, Mr. C. C. Martin, in the enforcement of the strictest discipline among the employés of the bridge. The bridge police force now numbers, 1 captain, 1 sergeant, 3 roundsmen 91 patrolmen and 1 storekeeper, making 97 in all.

## The Value of Time a Century Ago.

In looking over some old papers lately we found the following "bill of costs," as rendered in the Strafford Co. (Mass.) Superior Court for the September term of 1787. The valuation of a day's service and the allowance for travel, made at a time when travelling was supposed to be expensive, look rather low from our advanced stand point of rates. The items are as follows:—

| | £ | s. | d. |
|---|---|---|---|
| Travel last term | 0 | 3 | 0 |
| Attendance three days | | 4 | 6 |
| Subpœna and summoning six witnesses | | 7 | 0 |
| Their travel seventy miles | | 10 | 6 |
| Attendance, two days each | | 18 | |
| Filing, etc. | | 1 | 6 |

We cannot help mentally estimating what shape the money end of this bill would assume, were it figured out by some of the New York lawyers of the present year of grace.

## New Titles for Engineers.

The British Government has just granted the title of *Rai Bahadur*, or *Khan Bahadur* to all natives in the East Indian Public Works Department holding the "substantive rank" of Executive Engineers. Assistant Engineers are entitled to be addressed as *Rai Sahib* or *Khan Sahib.*

## PERSONAL

Walter Watson, C.E., of Pittsfield, Mass., has gone to Ohio to engage in railroad work; he will return in February.

D. B. Robinson has been appointed General Manager of the Colorado Midland R. R. Co., with headquarters at Colorado Springs, Col.

John Price, Jr., has been made a partner in the railroad contracting firm of John R. Price & Co, Topeka, Kan.

Mr. Money, Assistant Engineer of the Hudson Bay R. R., has taken up his quarters in Winnipeg, Manitoba, where he will remain until the completion of the road.

Maj. William H. H. Benyaard, U. S. Engineers, is ordered to San Francisco, Cal., to relieve Col. George H. Mendell, for years past in charge of the river and harbor improvements in that section.

A. R. Pharo, President of the Tuckerton Railroad Company, died of apoplexy, at his home in Tuckerton, N. J., on November 9th, aged seventy-three years.

William Brown, C. E., of Owensboro, Ky., who is interested in the Western Railroad, of Colombia, will leave shortly for Bogota, U. S. of Colombia, South America.

Norman G. Weaver, chief assistant of Lt. Col. G. Elliot, U. S. Engineers, at Newport, R. I., has resigned to accept the position of Assistant Superintendent of the St. Louis Bridge Co.

John W. Hill, M. E., having resigned his position as consulting engineer of the Cincinnati Water Department, has resumed his professional practice, with headquarters at Room 21, Glenn Building, Cincinnati, O. Mr. Hill offers his services as consulting engineer in all matters relating to water supply, with steam and hydraulic machinery as his specialties.

Sama J. Nakajimi, of the Imperial University, Tokyo, Japan, is with G. W. Pearsons, at Kansas City, Mo. He expects to stay about two years in the United States, and two in Europe, for the purpose of obtaining a practical knowledge of hydraulic and sanitary engineering.

The extensive and varied work now in progress at Kansas City, offers a good field for examination in hydraulic engineering, and the usual sanitary practice. The requirements of some of the Japanese cities, however, point to the necessity of sanitation by dry processes largely, and manufacturers of such goods may find it to their interest to forward him such descriptive pamphlets as they may have of their wares. His address is in care of Water-Works Office, Kansas City.

HARRY ROBERTS WHEELER, an Assistant Engineer on the New Croton Aqueduct, in charge of Shafts 2, 3 and 4, near Sing Sing, N. Y., was married on the 9th inst. to Miss Anne E. Moore, at Poughkeepsie. Mr. Wheeler was formerly connected with the N. Y., West Shore & Buffalo R. R.

MR. HORACE E. HORTON, of Rochester, Minnesota, Engineer and Contractor for the new bridge over the Mississippi river, at Dubuque, Ia., was in New York this week with the drawings and specifications of the new bridge, which, by agreement with the directors of the Bridge Company, had to be examined and approved by Theodore Cooper, Consulting Engineer. The pontoon bridge plan to be built at Dubuque, and which has been discussed for a half score o years, has been abandoned in favor of the new iron bridge. Mr. Horton is a well-known, successful bridge builder, is one of the few rich civil engineers of America, and we understand undertakes the entire construction of the new bridge with his own money.

### Liverpool Engineering Society.

A paper entitled, "Dredging at Whitehaven Harbor," by Mr. John S. Brodie, Engineer to the Town and Harbor Trustees of Whitehaven, was read by the honorary secretary (in the author's absence) at the last meeting.

A short description of the Harbor of Whitehaven, as regards the silting of the entrance to the harbor and the means adopted to keep the silt down, was given, and the opinion of the original engineer of the harbor works the late Sir John Rennie, P. P. Inst. C. E., as stated in his book on "Harbors," was quoted, as showing that that eminent harbor engineer fully foresaw the difficulty of preventing deposit of silt in harbors such as Whitehaven.

The three systems of "ladder" dredging "grab" dredging, and lifting sand from the harbor by means of steam cranes and manual labor were then described in detail as carried out at Whitehaven, analized, and compared; and the method of improving the fairway to the harbor by means of induced tidal currenst and the resulting advantages pointed out.

The paper concluded with a few general remarks as to the most efficacious and economical means of preventing deposits in close harbors situated on exposed alluvial coasts.

## CORRESPONDENCE.

### The Fall of the Gravesend Stand-Pipe.

EDITOR ENGINEERING NEWS:

The recent fall of the stand-pipe at Gravesend has brought out in a general way a lot of moral reflections on defective material and workmanship as usual in such cases, but the matter of distortion arising from the shape of the pipe itself has not been touched upon in any article which has come to my notice.

Every boy at school has of course seen in the books that rather priggishly named thing, called "The hydrostatic paradox," generally illustrated by a cut of a hydrostatic bellows. Now this Gravesend tower was a hydrostatic bellows on a large scale, in which the supply pipe of the bellows had an area of one-fourth of the bottom, or in other words it was an upright boiler shell, 16 feet diameter, under 100 pound per square inch pressure, amounting on the 16 feet to 2,895,298 pounds.

From this, deducting 1,710,000 pounds as the weight of tower, guys, galleries, and water, and we have a lifting force of 1,185,298 pounds. Some time previous to the accident, water was, it is said, pumped into the pipe, and finding that the upward pressure lifted the edge of the bottom three-quarters of an inch or so, it was braced with two sets of inside stays, twenty-four in each set. These stays ran from the shell to the bottom, at 20 and 40 inches from the circumference, and were of course from 15 to 20 inches apart. Now when the distorting strain took place, the outer row of braces got very little of the work, and the inner and longer ones—whose share on an even deal would be 24,693 pounds each, less the stiffness of the bottom plate—probably, got at least 40,000 apiece.

These braces being an after-thought and not originally specified were bolted to the bottom plate by two 1¼-inch bolts through a T-shaped foot, and apparently nuts were shoved under the bottom from the outside, as the bolts had a nut on each end.

When the gauge registered 100 pounds the inner braces had to take the work of preventing the springing of the bottom, and if there was a soft place in the foundation where any one brace was, or if the next brace was a little slack, or one of a good many other things occurred, and it was strained beyond endurance and gave way, the sudden blow this would give to the plate of the shell to which its upper end was riveted was fully enough to start a rupture in just the way it occurred.

It is a great pity that the bag at the bottom was made at all, as it answered no useful purpose and was a fatal blunder, and it is a greater pity that a tank of, say 20 feet diameter and 20 feet deep, had not been put up on a trestle 230 feet high at a good deal less than the contract price of the failure, which tank would have held in its 20 feet of height more than 120 feet of the 8 feet pipe would contain.

Yours respectfully,
JOHN F. WARD.

### The Sandusky Stand-Pipe.

EDITOR ENGINEERING NEWS:

As the Sandusky, Ohio, stand-pipe seems to have recently become a subject of more or less interesting discussion by several correspondents of the NEWS, and as this structure was constructed some ten years ago from my designs and under my general supervision as consulting engineer, I deem it proper to state, briefly, that the major part of the discussion is based upon erroneous premises, both as to altitude and thickness of metal. For instance, the pipe is 180 feet high, instead of 208 feet, and its lower ring or course is ¾ instead of ⅝-inch in thickness. Diameter, 25 feet.

Without wishing to occupy too much space in the discussion of formulas, factors, etc., and in fact not now having the leisure to do so, it may not be uninteresting to state the thickness of plates composing it, and other characteristics as follows—numbering from the bottom:

| Rings. | Feet. | Thickness of steel plate. Inch. | Steel rivets in vertical joints, (triple riveted.) Inch. |
|---|---|---|---|
| 2 | 8 | ⅞ | 1⅛ |
| 2 | 8 | ⅞ | 1⅛ |
| 2 | 8 | ⅞ | 1⅛ |
| 2 | 8 | ⅞ | 1⅛ |
| 2 | 8 | ¾ | 1 |
| 2 | 8 | ¾ | 1 |
| 1 | 4 | ¾ | ⅞ |
| 2 | 8 | ¾ | ⅞ |
| 2 | 8 | ¾ | ⅞ |
| 2 | 8 | ¾ | ⅞ |
| 2 | 8 | ¾ | ⅞ |
| 2 | 8 | ¾ | ⅞ (double riveted.) |
| 2 | 8 | ⅝ | 1 |
| 1 | 4 | ⅝ | 1 |
| 1 | 4 | ⅝ | ⅞ |
| 2 | 8 | ⅝ | ⅞ |
| 2 | 8 | ⅝ | ⅞ |
| 2 | 8 | ⅝ | ¾ |
| 2 | 8 | ⅝ | ¾ |
| 2 | 8 | ⅝ | ¾ |
| 1 | 4 | ⅝ | ⅝ |
| 2 | 8 | ⅝ | ⅝ |
| 2 | 8 | ⅝ | ⅝ |
| 3 | 12 | ½ | ⅝ |

All horizontal joints single riveted.

The plates and rivet rods were manufactured with the greatest care and uniform fidelity by the Otis Iron and Steel Co., of Cleveland, Ohio, and possessed a tensile strength (as shown by numerous and careful tests) ranging from 67,000 to 85,000 pounds, with elastic limit of 30,000 to 45,000 pounds per square inch of sectional area.

Trusting that the foregoing may prove of some interest to the profession, I am,

Very respectfully,
Toledo, O., Nov. 1, 1886. J. D. COOK.

### German Specifications for Standard Portland Cement Tests.*

*Definition.*—Portland Cement is a product resulting from the vitrifaction of a thorough mixture of materials, whose principal component parts are lime and alumina, and the grinding of the vitrified material to a fine powder.

1. *Packing and Weight:* As a rule Portland Cement is to be packed in standard barrels of 180 k.g. [397 lbs.] gross weight, and about 170 k.g. [374 lbs.] net weight and in half standard barrels, of 90 k.g. [198 lbs.] gross weight and about 83 k.g. [183 lbs.] net weight. The gross weight is to be marked on the barrels. If the cement is called for in bags or barrels of other weight, the gross weight of the same must be clearly marked upon these packages. Losses and variations in weight of the single packages up to 2% of the same will be allowed. Barrels and sacks, in addition to the weight, shall show in legible writing the name and trade mark of the manufacturer.

2. *Time of Setting:* Slow or quick setting cement may be called for according to the use to which the cement is to be put. Cements which do not set in less than two hours, are to be considered slow setting cements.

3. *Constancy of Volume:* Portland Cement shall be of constant volume. As a preliminary test, admitting of forming a rapid opinion, the heating test is recommended. The decisive test shall be that a paste of neat cement made on a glass plate protected against drying and placed under water, after twenty-four hours shall not show after the lapse of a longer period of time any blowing cracks, or change of shape.

4. *Fineness of Grinding:* Portland Cement shall be so finely ground that a batch of the same shall not leave a residue of more than 10% upon a sieve of 900 meshes per square centimetre (5806 meshes per sq. in.). The thickness of the wire of the sieve shall equal half the space between the wires. For each test batch 100 g. (3½ oz.) of cement shall be used.

5. *Tests of Strength:* The cohesive power of Portland Cement shall be determined by the testing of a mixture of cement and sand. The tests shall be both tensile and compressive, made according to a uniform method, with test pieces of the same form and cross section, and with the same apparatus. At the same time a determination of the strength of the neat cement is to be recommended.†

6. *Tensile and Compressive Strength:* Good slow setting cement, in the proportion of these parts by weight of standard sand to one part of cement shall have when tested, after twenty-eight days hardening, (one in air and twenty-seven in water) a minimum tensile strength of at least 16 k.g. q.c.m. (sixteen kilogrammes per sq. centimetre), (227 lbs. per sq. in.) The compressive strength shall be at least 160 k.g. q.c.m. (2270 lbs. per sq. in.)

Cement which shows a higher tensile or compressive strength admits in many cases of a greater addition of sand, and from this point of view, as well as on account of its greater strength for the same amount of sand, is entitled to a correspondingly higher price.

For slow setting cements the strength after twenty days is less in general than the one above specified, therefore, in giving the results of tests the time of setting shall also be given.

The tests shall be made in the following manner:

To determine the time of setting of cement, a slow setting neat cement shall be mixed three minutes, and a quick setting neat cement one minute with water to a stiff paste. A cake about 1.5 c. m. (0.59 in.) thick, with thin edges, shall be formed of this paste on a plate of glass. The consistency of the cement paste for this cake shall be such, that when brought with a trowel on the plate, the paste will only begin to run towards the edges of the same after the paste has been repeatedly jarred. As a rule 27% to 30% water will suffice to give the necessary consistency to the paste. As soon as the cake is sufficiently hardened, so that it will resist a slight pressure of the finger nail, the cement is to be considered as having set.

For the exact determination of the time of setting, and for determining the beginning of the time of setting, which latter is of importance in the case of quick setting cements, since they must be worked up before they begin to set, a standard needle 300 g. (10 oz.) in weight, and 1 q. m. m. (.00155 sq. in.) in cross section is used. A metal ring 4 c. m. (1.575 in.) in height and 8 c. m. (3.15 in.) clear diameter (inside diameter) is placed on a glass plate, filled with cement paste of the above consistency and brought under the needle. The moment at which the needle is no longer capable of completely penetrating the cement cakes is considered the beginning of the time of setting. The time elapsing between this and the moment when the standard needle no longer leaves an appreciable impression on the hardened cake is considered the time of setting.

For making the heat test (3) a stiff paste of neat cement and water is made, and from this, cakes 8 c. m. (3.15 in.) to 10 c. m. (3.94 in.) in diameter and 1 c. m. (.394 in.) thick, are formed on a smooth impermeable plate covered with blotting paper. Two of these cakes, which are to be protected against drying, in order to prevent drying cracks, are placed, after the lapse of twenty-four hours, or, at least only after they have set, with their smooth surfaces on a metal plate and exposed, for at least an hour, to a temperature of from 110° C. to 120° C. (230° to 248° F.) until no more water escapes. For this purpose the drying closets in use in chemical laboratories may be utilized. If, after this treatment, the cakes show no edge cracks, the cement is to be considered in general of constant volume. If such cracks do appear, the cement is not to be condemned, but the results of the decisive test with

*We are indebted to the Laboratory of the Department of Civil Engineering of Cornell University, at Ithaca, N. Y., for the above; that department having translated it from the original for its own use.
ED. ENG. NEWS.

†The testing without sand is especially to be recommended in the case of the comparison of Portland Cement with mixed cements and other hydraulic cements, since through the neat strength the higher value, that is to say the peculiar qualities of the Portland Cement which the other hydraulic cements lack, are better expressed than in the sand tests.

the cakes hardening on glass plates under water must be waited for. It must, however, be noticed that the heat test does not admit of a final conclusion as to the constancy of volume of those cements which contain more than 3 % of calcium sulphate (gypsum) or other sulphur combinations.

For making the final test, the cake made for the purpose of determining the time of setting, for slow setting cements, is placed under water, after the lapse of twenty-four hours, but, at all events, not until after it is set. For quick setting cements this can be done after a shorter period. The cakes, especially those of slow setting cements, must be protected against draughts and sunshine until their final setting. This is best accomplished by keeping them in a covered box lined with zinc, or under wet cloths. In this manner the formation of heat cracks is avoided, which are generally formed in the center of the cake and may be taken by an inexperienced person for cracks formed by blowing.

In order to obtain concordant results in the tests,sand of uniform size of grain and uniform quality must be used. This standard sand is obtained by washing and drying the purest quartz sand obtainable, sifting the same through a sieve with sixty meshes per square centimetre, (387 per sq. in.) thereby separating the coarsest particles,and by removing from the sand so obtained, by means of a sieve of one hundred and twenty meshes per square centimetre (774 per sq. in), the finest particles. The diameter for the wires of the sieves shall be 0.38 m. m. and 0.32 m. m. (.015 in. and .013 in.) respectively. Since not all quartz sand, even under the same method of treatment, gives the same resulting strengths in the mortars, one must know whether the standard sand at one's disposal gives concordant results with the standard sand furnished by the German Society of Cement Manufacturers and also used at the Royal Testing Station at Berlin (Charlottenburg).

For each test, in order to obtain correct average results, at least six test pieces are to be made. Tensile test pieces can be made either by hand or by machinery.

*Hand Work*: On a metal or thick glass plate five sheets of blotting paper soaked in water are laid,and on these are placed five molds wetted with water. Two hundred and fifty grammes (8.75 oz.) of cement, and seven hundred and fifty grammes (26.25 oz.) of standard sand are weighed and thoroughly mixed dry in a vessel. Then one hundred cubic centimetres (100 g. or 35 oz.) of fresh water are added, and the whole mass thoroughly mixed for five minutes. With the mortar so obtained the molds are at once filled, with one filling, so high as to be rounded on top,the mortar being well pressed in. By means of an iron trowel five to eight centimetres (1.96 in. to 3.14 in.) wide, thirty-five centimetres (13.79 in.) long, and weighing about two hundred and fifty grammes, (8.75 oz.), the projecting mortar is pounded, first gently and from the side, then harder into the molds until the mortar grows elastic, and water flushes to the surface. A pounding of at least one minute is absolutely essential. An additional filling and pounding in of the mortar is not admissible, since the test pieces of the same cement shall have the same densities at the different testing stations. The mass projecting over the mold is now cut off with a knife, and the surface smoothed. The mold is carefully taken off and the test piece placed in a box lined with zinc, which is to be provided with a cover, to prevent a non-uniform drying of the test pieces at different temperatures. Twenty-four hours after being made, the test pieces are placed under water, and care has to be taken that they remain under water during the whole period of hardening.

*Machine Work*: After the mold, provided with a guide mold, has been clamped, by means of set screws, on the bed plate of the pounding machine, for each test, one hundred and eighty grammes (6.3 oz.) of the mortar, made as above, are placed in the mold and the iron follower is set in. By means of Boehme's hammer apparatus, with a hammer weighing two kilogrammes, (4.4 lbs.), one hundred and fifty blows are struck on the follower.

After the guide mold and follower have been removed, the test piece is scraped off, smoothed, taken with the mold from the bed-plate and for the rest treated as for the hand work. By accurately following the directions given above, hand and machine work give well concording results. In all cases of doubt the machine work is to be decisive.

*Compressive Tests*: In order to obtain concordant values in compression tests at different stations machine making is necessary. Four hundred grammes (14 oz.) of neat cement, and twelve hundred grammes (42 oz.) dry standard sand are thoroughly mixed dry in a vessel, and one hundred and sixty cubic centrimetres (5.6 oz.) of water are added thereto, and then the mortar is thoroughly mixed for five minutes. Of this mortar eight hundred and sixty grammes (30 oz.) are placed in the cubic molds, provided with guide mold, and the mold is then screwed on the bed plate under the pounding machine. The iron follower is placed in the form and, by means of Boehme's Trip Hammer, one hundred and fifty blows are struck, by a hammer weighing two kilogrammes (4.4 lbs.).

After removing the guide mold and follower, the test piece is smoothed off, taken with the mold from the bed plate, and for the rest treated as for hand work, as given above.

*Making Test Pieces of Neat Cement*: The inside of the molds are slightly oiled and the same are placed on a metal or glass plate without blotting paper. One thousand grammes (35 oz.) of cement are weighed out, two hundred grammes (7 oz.) of water are added and the whole mass thoroughly mixed for five minutes (best with pestle) The forms are well filled, (rounded), and then proceed as for hand work, as given above. The molds can only be taken off after the cemeat has sufficiently hardened. Since, by the pounding in of the neat cement, test pieces of uniform consistency are to be obtained, for finely ground or quick setting cements, the amount of water must be correspondingly increased. The volume of water used is always to be stated in giving the strength obtained.

*Treatment of Test Pieces at Time of Testing*: All specimens are to be tested directly after their removal from the water. Since the time of tearing is of influence on the result in tensile tests the increase of load shall be one hundred grammes (3.5 oz.) per second. The mean of the four best results shall be considered the final tensile strength. In testing compression pieces, the pressure is always to be exerted on two side faces of the cube, but not on the bottom or top. The mean of the four highest tests shall be considered as the final compressive strength.

## Ontario & Quebec Railway Bridges.

The bridges over the river Ottawa at St. Anne's and Vaudreuil on the eastern extension of the Ontario and Quebec Railway, from Smith's Falls to Montreal, are rapidly approaching completion. At St. Anne's, out of thirteen piers, six are finished, five are half finished, and at the remaining two the foundations are in. One abutment is nearly completed and the foundation of the other is ready for the masonry.

At Vaudreuil, out of sixteen piers, ten are very nearly finished, four are more than half finished, and the foundations of the remaining two are above water. The east abutment is completed, and the west one nearly half built.

At a small bridge of two spans between St. Anne's and Vaudreuil, one abutment and the pier are finished.

The contractors, Messrs. Wm. Davis & Sons, of Ottawa, are vigorously pushing the work, and it is confidently expected that the whole of the masonry in these three bridges, embracing about 12,000 yards of first-class masonry, besides a thousand or two of concrete, will be entirely finished by the end of November.

The contractors for the superstructures, the Union Bridge Company, of New York, are making preparations for erecting the spans, and the first shipment of iron is daily expected from England.

Operations upon these bridges were only commenced in June last, and they are therefore instructive instances of rapid construction,especially so when it is considered that all the work of every kind in connection with them is of the very highest quality. Mr. C. E. W. Dodwell, Assoc. Mem. Inst. C. E., is resident engineer, and Mr. H. W. Keefer, first assistant.

## LITERATURE.

*Pocket-Book of Tables and Formulae for Railroad Engineers; embracing, besides the usual tables and formulae, those for running Transition Curves.* By B. H. HARDAWAY, A. B., B. E. New York, 1886; E. & F. N. Spon, publishers. Size, 7x4½ inches, pp. 48; with about the same number of blank pages included with the tables. Price, $2.00.

This pocket-book contains the usual tables of natural sines, cosines, tangents and cotangents. The portion devoted to railroad curves, etc., is not very full, but includes those usually employed by the practicing engineer, for whom this book is especially intended. Levelling by barometer and tables of heights corresponding to barometric readings, and metric curves with formulæ and metric curve distances, are among the novel features in this pocket-book. Considerable space is devoted to the consideration of transition curves, or the flattening of curves at tangent points. This pocket-book generally assumes that the man using it is pretty well posted in the routine work of his profession. A feature that has good points is the accompanying blank-book with a pocket in the back cover made to hold the back of the pocket-book, thus uniting in one book the printed tables and rules and any manuscript notes the engineer may see fit to add.

*Accidents in Mines, in the North Staffordshire Coalfield, arising from Falls of Roof and Sides; their causes and the means of diminishing their frequency. With Detailed Sections of the Workable Seams, and an Account of the System of Timbering in vogue in that coalfield and applicable elsewhere.* By ARTHUR ROBERT SAWYER, Assoc. of the Royal School of Mines and one of H. M. Inspectors of Mines. New York, 1886. John Wiley & Sons, Publishers. Size, 6x9⅛ inches, pp. 101, and a great number of folding plates. Price, $7.00.

By a reference to the statistics of fatal accidents in mines it will be seen that more men are killed in the aggregate by falling roof and sides than by any other class of accidents. With the purpose of thoroughly investigating this fatal factor in mining, Mr. Sawyer has personally measured, and here illustrated, a section of every one of the numerous coal and ironstone seams in the district named. In general he has selected a typical working place, showing the actual timbering used, and has in nearly each case introduced the figure of a miner in a working position to show at a glance the scale of the surroundings. His purpose in this work is to show how some of the accidents are caused and to point out certain precautions which would, in his opinion, lessen the danger in these mines, at least. The author first describes the nature of the rock occurring in roofs, and the faults, slips and joints usual to that rock; he then describes the method of working and its usual effect on the roof. The portion of the work devoted to timbering, taken in connection with the illustrations, is valuable. Mr. Sawyer describes generally and specifically the manner of setting and drawing timbers, and shows by actual examples where faulty timbering was the cause of fatal accidents. In conclusion, the author gives rules for timbering as based on the method of working, nature of the roof and inclination of the seams, for various mines. This book should be not only interesting to miners but be found prolific of valuable hints and advice. We must add, however, that it will take a practical miner to intelligently read the text, which is filled with expressions and terms that belong peculiarly to the miner's vocabulary, and are obscure to the uninitiated reader.

## WATER.

EELS IN WATER PIPES.—At New Bedford, Mass, there has been much trouble caused recently by eels in the water pipes. They got into the new Worthington pumping engine in such numbers that the valves would not close, and they had to be cleared several times. An eel weighing 5½ pounds was taken from the pumps and many smaller ones got into service pipes and choked them up.

WATER METERS.—There has been considerable complaint of defective meters at Columbus, O.; they register full capacity at first but soon get so impaired that the Trustees say if they were generally used the receipts would not be sufficient to pay for wages and coal. The meters were guaranteed to work but do not fulfil the requirements.

WATER SUPPLY.—At the meeting of Chief Fire Engineers at Providence, R. I., Chief Leshure,of Springfield Mass., read a paper on water supply. He stated that the usual practice of granting a franchise to a private company is not always satisfactory as it often happens that the pipes laid are too small, the probable growth of the place not being sufficiently allowed for. If twenty 1-inch streams should be required for a vertical throw of 75 feet, the draught on the reservoir would be 3,000 gallons per minute. The friction of the resistance in the pipes is given as follows: for one stream of 150 gallons per minute through a 3-inch pipe it will be 14.25 pounds; for 8-inch pipe, 1,000 feet, five streams, the loss is 5.36 pounds, fifteen streams 46.64 pounds; while in 12-inch pipe, same length and number of streams, it is only 6.27 pounds; with twenty streams, 3,000 gallons a minute, through 1,000 feet of 10-inch pipe, the loss would be 27.25 pounds, while with 36-inch pipe and 5,000 feet distance it is only .28 pound. The velocity of the flow per second through a 36-inch pipe is 945 feet, through a 10-inch pipe 12.25 and through a 3-inch pipe 6.81. By experiments made last year, it was shown that with 50 feet of one-inch hose discharging 15 gallons a minute through a ¾-inch nozzle the loss was 7 pounds, and that the same pressure at the hydrants and the same length of hose, but with a ⅝-inch nozzle, the loss was 40 pounds. The resistance in 300 feet of 2½-inch hose, with a 1¼-inch nozzle, was 57½, while the use of the same length of hose and the same size of nozzle

the form being changed to a ring, shows a loss of 47½ pounds, a difference of 10 pounds, merely on account of the form of the nozzle, the discharge of water being 23 gallons less. The difference in friction is more apparent in the use of siamese hose. One line of 300 feet, 1¼-inch smooth nozzle, showed a loss of 70 pounds: with two lines the loss is reduced to 47½ and with three to 44, discharging 166 gallons a minute more than with one line. The gauges require constant watching, and should be frequently tested while experimenting with any system.

GEO. W. RAFTER, C. E., sends us his delayed final report on the Fredonia water-works, N. Y. While his preliminary estimate of cost was $90,000, the actual construction cost has been $71,375. The work was done by Messrs. Skidmore, Chambers & Jenkins, who took the contract December 31, 1883, and finally finished the work in September, 1884. To date of report fifty-six fire hydrants were set. The head of water in the principal part of the village is 240 feet, and the report includes a dissertation on water-rams and the best means of preventing them. The water rates already amounted to $1,200 per annum, and $3,000 is expected in the next year. The village owns the works.

LAKE VIEW, ILL.—Mr. John W. Alvord, Town Engineer, has submitted his report on the necessity for an extension of the water supply. Water-works have been in operation since June 1st, 1876, on the direct pressure system, after the designs of the former engineer, Mr. John A. Cole; this system being necessary as there is no high land available for a reservoir. The works have already cost $341,000 and during the past season the new pumping engine put in in September, 1885, has been taxed to its utmost capacity. The maximum amount estimated for the increased supply is 140 gallons per head per day. The present capacity of the works is stated to be about as follows: pumping engines, 10,000,000 gallons per day; inlet pipes, 8,000,000 gallons per day; force mains, 4,000,000 gallons per day; and the distribution system of nearly 50 miles of pipe consists of 48 per cent. 4 inches diameter, 31 per cent. 6 inches, 11 per cent. 8 inches, and 10 per cent. 12 inches; it is recommended that in future no pipes smaller than 6 inches diameter should be laid, and that new mains of 14, 16 and 20 inches diameter be laid where required. The two inlet pipes are of wrought-iron, 16 and 20 inches diameter, extending 1,700 and 2,000 feet, respectively, into the lake, and are provided with flexible joints at suitable distances; the lake end of each pipe terminates in a wrought-iron submerged crib, 16 feet square, while the shore ends terminate at the bottom of suction wells. A brick tunnel, 5 feet in diameter, is recommended, to extend one mile into the lake and terminating in a submerged crib; the supply would be over 40,000,000 gallons per day, and the cost about $100,000. Analyses of the water and examinations of the lake currents are also recommended. The pumping plant consists of four boilers, one duplex, compound, condensing, pumping engine of 5,000,000 gallons capacity, one double condensing engine and geared pumps of 3,000,000 gallons capacity and one double condensing engine with geared pump of 2,000,000 gallons capacity; it is recommended that a high duty pump of 6,000,000 gallons capacity and two new boilers be put in; the engine to be of some well established design. The total cost of improvements up to 1890 is estimated at $235,326.

WATER-WORKS STATISTICS.

One of the arguments used by those who oppose the building of water-works for Carrollton is that the city is too small to sustain or afford such a public improvement. The real value of such a protest can best be learned by investigating the history of water-works and learning what towns as small or smaller than Carrollton have done. The ENGINEERING NEWS, of New York, has published a book of statistical tables concerning water-works, compiled by J. J. R. Croes, civil engineer. From this book a number of pertinent facts may be learned. It is dated January 1885, and mentions no water-works built since that time.

There were known to be at that time in the United States 1,008 towns supplied with water-works. Of these 459 are owned by the towns, 5 are owned nominally by private companies, the stock being controlled by the towns, 500 are owned by private companies, and of 44 the ownership is unknown. In 624 towns the water is supplied by pumping, and in 196 the pumps deliver directly into the mains, constituting what is called the direct pressure system.

That Carrollton is not too small for water-works is evident from the fact that 244 of the towns having water-works in January 1885, contained by the census of 1880 less than 2,000 inhabitants and 85 less than 1,000 inhabitants. A few figures taken from the reports from some of these towns may be given to show that probably Carrollton can secure water-works at a reasonable expense, and may be interesting.

Rochelle, in the northern part of this state had in 1880, 1,893 population. The water-works were built in 1877 by the city at a cost of $19,000, and the water is supplied by direct pressure.

Greenville had in 1880, 1,886 population and her system, built in 1884, cost $16,000. Monticello, Iowa, population 1,877, built water-works in 1878 at a cost of $16,600 and reports $900 expenses and $1,000 receipts.

DeKalb, Illinois, has 1,598 population and water works costing $34,000. McPherson, Kansas; paid $8,000 for water-works. Her population was 1,590 in 1880. Hundreds of other towns might be enumerated. El Paso, Illinois, population 1,390, cost of water-works $6,000.

It is also worthy of note that 193 towns are supplied by surface water, and this when filtered at the pumping works, as can easily be done, furnishes the best and purest water.

The above figures demonstrate, 1st, that many towns no larger than Carrollton have thought it wise to build water-works; 2d, that their experience makes it ridiculous to say that Carrollton cannot be supplied with water for $25,000 or $30,000, 3d, that the direct pressure is quite generally used, and 4th, that surface water is in many cases a satisfactory source of supply.

The committee appointed by the common council to learn what amount of money would be required for water-works for this city are in correspondence with manufacturers, but have not completed their estimates. When they have done so the proper time will have come for Carrollton voters to say whether the city wants to make the investment.—Carrollton, Ill., *Patriot*.

LONDON (ENGLAND) WATER SUPPLY.

A report, dated October 7th, prepared for and at the joint expense of the companies (except the Kent) by Mr. William Crookes, F.R.S., Mr. William Odling, F. R. S. (professor of chemistry at the University of Oxford), and Mr. C. Meymott Tidy (professor of chemistry and of forensic medicine at the London Hospital, and medical officer of health for Islington), and addressed to the Official Water Examiner under the Metropolis Water Act, 1871, states: "We submit herewith the results of our analyses of the 182 samples of water collected by us during the past month, at the several places and on the several days indicated, from the mains of the seven London water companies taking their supply from the Thames and Lea. Of the 182 examples examined, the whole were found to be perfectly clear, bright, and well filtered.

Altogether the character of the London water supply has continued to be excellent throughout the past month. The mean proportion of organic carbon in the Thames-derived supply was .133 part, with a maximum in any one sample of .151 part, in 100,000 parts of the water, as against a mean of .141 part, and a maximum of .177 part in the preceding three months' supply.

The succeeding paragraphs set forth the general results of a third series of bacteriological experiments, made in continuation of those described in our two previous monthly reports. In these experiments, Thames-derived ordinary town-supply water was sterilized during the passage through it of a current of sterilized carbonic acid, so as to retain the earthy carbonates in solution. After sterilization, it was allowed to become re-aërated, by standing for 48 hours in cotton-plugged flasks before being subjected to experiment. In each experiment, by means of sterilized pipette bulbs, as nearly as might be of equal capacity, a quantity of peptone fluid, loaded with an active sporeless growth of *bacillus anthracis*, was added to the sterilized water, in the proportion, roughly, of $\frac{1}{10}$th or $\frac{1}{20}$th of its bulk; though it is possible that this proportion may, now and then, have been more or less departed from. To contaminate to the same extent the entire daily flow of Thames water from which the daily London supply is withdrawn, would require an addition thereto of over 1,000,000 gallons of bacillus-charged animal fluid; while to contaminate to the same extent a days's supply of the Thames water actually withdrawn, would require an addition thereto of at least 100,000 gallons of the same animal fluid. The experiments were made mostly on different days, from May 4th to May 19th inclusive. In 12 duplicate experiments, the infected water was kept at the temperature of the room, which ranged from 58° to 63° F. (14.5 to 17.5° C.); while in four single experiments, it was maintained artificially at the temperature of 90° F. (32° C.) After intervals of half-an-hour, and again after intervals of six hours, tubes of sterilized culture-fluid were sown with the infected water, and subjected to incubation for 18 hours and longer at 90° F. (32° C.). The general result of this series of experiments is as follows:

The tubes of culture fluid, sown with the infected water within half-an-hour of its having been infected, were found invariably to exhibit, after 18 hours incubation, a characteristic growth of bacillus. As regards the sowings made with the same infected water that had afterwards been kept for six hours at the temperature of the room, in one of the 24 tubes of culture fluid, corresponding to the 12 duplicate experiments, there was some growth of bacillus observable after its incubation for 18 hours; but subsequent sowings with this particular specimen of infected water, made the next morning, proved wholly infertile on incubation, though kept up for a period of three days. In the other 23 tubes of culture-fluid, sown with water that had been infected six hours previously and kept at the temperature of the room, there was no development whatever of bacillus after an incubation extending in each experiment to three, and in some instances to four days. Similarly, with regard to the four experiments in which the culture fluid was sown with water that had been infected for six hours during which it was maintained at the temperature of 90° F., in no instance did the sowings prove fertile on even prolonged incubation.

Subsequent series of experiments were undertaken, with a view to ascertain whether the duration of the period of infectivity, in purposely infected river water in its ordinary state, differed at all from that observed in the case of the sterilized river water; and also to ascertain the influence of a greater or less proportion of added nutrient animal fluid in prolonging or diminishing the duration of the period of infectivity. Particulars of these series of experiments will be given in future reports."

## NEWS OF THE WEEK.

### Railroads, Bridges and Canals.

**Storm King Bridge.**—The Lehigh & Hudson River R.R. Co. and the N. Y. Ontario & Western R. R. Co. have signed an agreement with General Manager Swan, of the Storm King Bridge Co., to aid the construction of the bridge and the connecting line to the N. Y. & New England R. R.; they also agree to make a traffic arrangement to send 2,000,000 tons of freight eastward over the bridge.

**Railroad Affairs in China.**—Captain H. Schuyler Ross, U. S. Navy, who has recently returned from China states that the efforts of capitalists of other nations to build railroads have not been successful so far. General Wilson is there looking after this work for American interests and has the sanction of the State Department. Americans are looked upon with more favor than other foreigners, but the government has discontinued sending young men to this country and Europe as they become dissatisfied with their country on their return.

**Mexican National R. R.**—E. A. Handy, chief engineer of the Northern division, is in San Antonio, Tex., to engage engineers and a construction force to resume work. The road was projected by a syndicate and completed some distance beyond Saltillo, 245 miles from New Laredo, but owing to financial embarassments no work has been done for nearly four years. A loan of $5,000,000 has been negotiated with English capitalists for the completion of the Northern division from Saltillo to San Luis Potosi, 225 miles; as this is a station on the Tampico line of the Mexican Central R. R., the new line will be a most important connection, giving a route from New York or Chicago to the city of Mexico about 1,000 miles shorter than the present route via El Paso. Mr. Handy expects to proceed with the road-bed at the rate of a mile per day, and to have trains running to San Luis Potosi by May, 1887.

**St John Valley & Riviere du Loup R. R.**—H. A Hancox, Chief Engineer, writes us that surveys and plans have just been completed by him for a steel truss railway bridge to cross the St. John river at Fredericton, N. B. This bridge will be 2,238 feet long; made up of nine spans and a draw, viz.: Seven spans of 250 feet each, and two spans of 170 feet and 158 feet, the draw 160 feet. Steel is proposed as the material, with cut stone masonry piers and abutments. The estimated cost is $309,864. The survey for the railroad, from Fredericton to Woodstock, is completed, the distance being 62½ miles; construction will be commenced in the spring.

**Poughkeepsie Bridge.**—A despatch has been going the round of the daily press to the effect that the charter of the old Poughkeepsie Bridge Co. will expire in December next and that opposition will be made to any granting of an extension of time. The Poughkeepsie *Eagle* states that in point of fact the charter does not expire until January 1st, 1888, by which time the bridge will be far towards completion. Mr. Paine, chief engineer of the Manhattan Bridge Building Co., paid a visit recently to the works of the Union Bridge Co., at Athens, Pa., to inspect the manufacture of the steel work for the bridge.

**Midland R. R. Co. (England).**—The annual rate of capital expenditure which has averaged $10,000,000 for many years has been materially reduced. The total outlay for the half year ending June last was $2,333,670, the greater part of which was for lines in operation and extensions; the new freight depot at St. Pancras, a part of which will be available for traffic by January, took $208,700. The estimate of future expenditure, which in June and December, 1885, was $19,345,000 and $16,640,000, respectively, now stands at $14,330,000 of which about $2,500,000 will be expelled during the current half year.

**Torpedoes.**—The Navy Department has appointed a board before which persons interested in the development of torpedoes, for naval use, can exhibit their torpedoes, models and designs, and perform such practical experiments as may appear advisable. Persons wishing to avail themselves of this opportunity should communicate with Montgomery Sicard, Chief of Bureau of Ordnance, Navy Department, Washington, D. C.

**Railroads in Sweden.**—Sweden, the last European country to build railroads, has now 4,281 miles of road open. In 1867 it had but 1,000 miles. The gauges in use include 3 feet, 3 feet 4 inches, 3 feet 6 inches, 3 feet 7½ inches, 3 feet 11 inches, and 4 feet 3½ inches. The average cost per mile as constructed was $28,500; the cost to private companies being about $23,650 and to the State, $41,500 per mile. The profits are 4 per cent. for the private, and 3½ per cent. for the State lines; but some of the lines made as much as from 12½ to 15 per cent., despite scant population and small traffic.

**Steel Ties.**—An inspection has recently been made of 1,330 yards of track of the North Eastern R. R. (England) which were laid with steel ties in March 1885; the ties are 9 feet long, 8 inches wide at top with 2 inch flanges at each side and 10 inches wide between the flanges. The chairs are of steel fastened to the ties by steel rivets. The inspection shows that after about nineteen months of service there is the least possible corrosion underneath and none on the upper portion, while all the rivets have kept good, which is considered as remarkable in view of the heavy express and other traffic over the line. They are estimated to last 20 or 25 years as against 12 or 14 for wood, and though they are double the cost and more difficult to lay, when once in they give much less trouble than wooden ties. These ties were made by the Barrow Hematite Iron & Steel Co.

**Railroads of Japan.**—The first railroad in Japan was a single track line between Tokio and Yokohama, work was commenced in 1870 and the line was completed and opened in 1872; a second track was laid in 1880, and the equipment in 1884 consisted of 16 locomotives, 82 passenger and baggage cars and 154 freight cars At the end of March 1885, 266.25 miles were in operation, their cost having been $17,238,800; 272.5 miles are now under construction, and 524.37 miles are being surveyed. The roads are divided in to two systems, one owned and operated by the State, the other by the Japanese R. R. Co.; the former system has 184.37 miles in operation, 272.5 miles under construction, and 123.75 miles being surveyed; the latter system comprises 86.88 miles in operation and 400.63 miles being surveyed. The locomotives are obtained from abroad, mostly in England; formerly the cars were built in England but the government has now established car shops at Shinbasi, where a number of cars are now built.

**Smith's Falls and Montreal Short Line.**—Over 150 men and 20 teams are at work ballasting and switch building in the yard at Smith's Falls, in addition to a large number at other work. The main line from the junction to the lower end of the yard is already well ballasted, and grading is being done for a double track to extend from the old track to a point about 1½ miles below the yard. The ground is also being rapidly prepared for nine switches, which will each be from 2,000 to 3,000 feet long. At the lower part of the yard a large culvert is to be built under all the switches, and gangs of men are working towards this point from both ends. Work at the round house is already under way. Thirteen stalls are to be built this fall, and the foundations of these are already built. Switches are being built from each end of the yard to the round house. When completed there will be stall room for forty engines, and this room will be required next summer. Now that the track is laid, its excellence can be plainly seen. The rails are 72 pounds to the yard, are laid on ties an inch wider and a foot longer than the ordinary standard. They are connected by clamps of unusual size and strength, and are splendidly laid in ballast 1½ feet deep. Drew, Lewis & Co., are the contractors.—Smith's Falls *Independent*.

**Central and South American Railroads.**—Work is progressing on the new line in Costa Rica, which will connect the two existing railroads, and form a complete system between the capital and the principal seaport; the line is 48 miles long, and the contract includes a pier at Limon and additional rolling stock. The Government has completed 71 miles on the Atlantic side, 26 miles in the interior, and 13 miles on the Pacific side, from Punta Arenas to Esparta.—The Nicaraguan Government has granted a concession for a railroad from Lake Nicaragua to the Escondido river, a navigable stream flowing into the Atlantic; this road connecting with an existing line from Corinto, on the Pacific coast, to the lake, will complete the interoceanic system; the concessionaire, Pedro B. Ramirez, has come to New York to arrange for the construction of the road.—The Western R. R. Co., United States of Colombia, has been granted an extension of the concession by President Nunez; the government has granted the company $1,000,000. Mr. William Brown, Owensboro, Ky., a civil engineer, and a member of the company, will leave for Bogota shortly.

**Burnt Clay Ballast.**—The Chicago, Burlington & Quincy R. R. Co., the Union Pacific R. R. Co. and other western companies are laying burnt clay ballast. To prepare the ballast, the soil is stripped off for a length of 300 to 1,000 feet—whatever length of train for loading is desired—and a fire started with kindling. On this a mixture of slack and pea coal is sprinkled, then a thin layer of clay, two to three inches thick, then another good sprinkling of coal, then more clay and so on indefinitely, in the proportion of about one ton of coal to eight cubic yards of ballast. When fully burned the pile is about 8 feet high and 20 to 30 feet wide and from four to five months are consumed in burning it, a small gang of men being on hand constantly to feed the pile. One gang will ordinarily burn from 24,000 to 25,000 cubic yards at once, and its cost on the cars at the pits is about eighty cents per cubic yard. After the first rain the ballast is not dusty and it does not crumble.

## Contracting.

**Retaining Walls.**—At Newport, R. I., the contract for retaining walls at the sewer outlet has been awarded to Wm. Beattie, Fall River, Mass., at $6.75 per cubic yard.

**Excavation.**—The contract for excavating and refilling a trench for water pipe at Yonkers, N. Y., has been awarded to John Forsyth, Kingsbridge, at 57 cents per foot.

**Drain.**—The contract for a drain at Albany, N. Y., has been awarded to John Doyle at the following prices: drain, 90 cents per lineal foot; Y-branch, $2.40; manholes, $55 each.

**Pipe.**—The contract for iron pipe at Newport, R. I., has been awarded to the McNeal Pipe & Foundry Co., New York City, at $38 per ton. The other bids were: Gloucester Iron Works, Philadelphia, $39 90; Warren Foundry & Machine Co., New York City, $42; and Camden Iron Works, Philadelphia, $48.

**Stone.**—Rubble stone for the harbor of refuge, Sandy Bay, Cape Ann, Mass.: Rockport Granite Co., 71 cents per ton; Charles H. Edwards, Quincy, Mass., 86 cents per ton.

Stone for repairing dike in Connecticut river above Hartford, Conn.; Charles C. Goodrich, Hartford, $1.50 per cubic yard; Charles H. Edwards, Quincy, Mass., $1.61.

Stone for increasing height of dike at Hartford, Conn.; Charles C. Goodrich, $1.09 per ton; Charles H. Edwards, 99 cents; F. H. Smith, New York, $2.39.

**Road.**—The contract for a road to the Chalmette Cemetery, New Orleans, has been awarded by Col. Batchelder, deputy quartermaster general, U. S. A., Washington, D. C., to Robert McNamara at the following prices:—earthwork, 20 cents per cubic yard; oyster shells, $1.25; clam shells, $2.75; gravel, $2.75; brickwork, per 1000, $22.50; 8-inch pipe, 50 cents; 10-inch, 60 cents; 12-inch, 80 cents; covers for flumes, 50 cents per sq. ft.; gratings, $1.50. The bid did not include the macadam work, on which other parties bid $3.75 and $16 per cubic yard

**Dredging.**—The following bids for dredging in Wilmington harbor were opened November 5th: Baltimore Dredging Co., 24 cents per cubic yard; George C. Forbes & Co., Baltimore, Md., 24 cents; Frank C. Somers, Philadelphia, 24.9 cents; National Dredging Co., Wilmington, Del., 22 cents; W. H. W. Morris, New York City, 23.75 cents; American Dredging Co., Philadelphia, 23 cents. All the bids were rejected as being excessive.

The following proposals for dredging in the James river, Va., were opened November, 10th, by Lieut. Col. W. P. Craighill, U. S. A.: Jas. Caler & Son, Norfolk, Va., 12.5 cents per cubic yard; Morris & Cummings Dredging Co., New York City, 22 cents; J. N. Lamkin, Cool Well, Va., 24 cents; Ross & Sanford, Jersey City, N. J., 25.5 cents; Geo. E. Ward, Georgetown, D. C., 27 cents. The contract was awarded to Jas. Caler & Son.

**Garbage Disposal.**—The following are the bids received last week for disposing of the garbage at Brooklyn, N. Y.; all the bids received a short time ago having been rejected.

John H. O'Rouke, collecting and burning garbage: One year, $85,000; two years, $175,000; three years, $255,000; four years, $345,000; five years, $430,000. Collection and removal by sea: One year, $56,000; two years, $116,000; three years, $176,000; four years, $251,000; five years, $326,000. Collecting and depositing garbage one mile outside the city limits: One year, $55,000; two years, $110,000; three years, $180,000; four years, $255,000; five years, $335,000.

Thomas F. White, collection and removal by boat for a five years' term: One year, $50,000; two years, $110,000; three years $165,000; four years, $218,000; five years, $268,000.

Peter Blake, for collecting and burning the garbage: First year, $70,000; second year, $70,000; third year, $80,000; fourth year, $80,000; fifth year, $85,000. Collecting and removal by boat: First year, $70,000; second year, $80,000; third year, $80,000; fourth year, $90,000; fifth year, $100,000. Collecting and removing garbage one mile outside the city: First year, $50,000; second year, $370,000; third year, $80,000; fourth year, $80,000; fifth year, $90,000.

George F. Swift, collecting and removing garbage by land: One year, $65,000; two years, $135,000; three years, $200,000; four years, $265,000; five years, $335,000.

Henry Berau, collecting and burning garbage: First year, $85,000; second year, $85,000; third year, $75,000; fourth year, $70,000; fifth year, $70,000. Collecting and removal by boat: First year, $16,000; second year, $63,000; third year, $60,000; fourth year $55,000. Collecting and removal one mile outside the city: First year, $75,000; second year, $65,000; third year, $60,000; fourth year, $60,000; fifth year, $60,000.

Charles Hart, collecting and burning: First year, $85,000; second year, $86,000; third year, $89,000; fourth year, $92,000; fifth year, $94,000. Collecting and removal by boat: First year, $72,000; second year, $75,000; third year, $77,000; fourth year, $79,000; fifth year, $80,000. Collecting and removal one mile outside the city: First year, $67,000; second year, $69,000; third year $71,000; fourth year, $73,000; fifth year, $75,000.

The appropriation for next year is $50,000. Under the law the Commissioners have the power to make a contract for a sum in excess of the appropriation or any one year. The appropriations are made annually. If the contract price for next year should be greater than the amount of the appropriation, the deficiency would be made up out of the Revenue Fund.

**Levee Work.**—The following is a statement of the work being done under the supervision of the Board of State Engineers, Louisiana: Good Hope levee, Charles Nolan, 12.99 cents per cubic yard; Almedia, John Cleary, 12⅞ cents; La France, Martin Head, 15 cents; Gypsy, John Cleary, 14⅞ cents; Houmas and Uncle Sam, Thomas O'Malley, 14 cents; Arlington and Woodburn, P. J. Tyrrell, 14.24 cents; Preaut, A. J. McPhail, 12.99 cents; St. Emma, Charles Nolan, 12.99 cents; St. James Estate, J. J. Frawley, 13¾ cents; Cabanocey, P. J. Tyrrell, 17.5 cents; Highland and Bivouac, Geo. Dionne, 19 cents; Upper Ten, P. Harnan, 20 cents; Woodland, P. J. Tyrrell, 21.24 cents; Star, Martin Head, 15.25 cents; Louisa, John Cleary, 14⅞ cents; Marrero, Ogden & Jones, 14¾ cents; Cofield, W. H. Davis, 14 cents; Welcome Store and Pointe Celeste, Martin Head, 14⅞ and 13.99 cents; Big Bend, J. N. Ogden, 15 cents; Lakeland, John Ryan, 14⅜ cents; New Texas, Morgan O'Connel, 14¾ cents; Morganza, P. J. Trezevant, 25 cents; Lobdell Brady, John B. McGinty, 17 cents; Pointe Manoir, Ogden & Jones, 15.72 cents; Plaquemine City, Robt. McNamara, 19⅞ cents; Lagarde and Sevin, Wm. Dowling, 17 cents; Energy, P. J. Tyrrel, 18.24 cents; Mascot and Shipp's Bayou, John B. Reid, 15⅞ and 27½ cents; St. Gabriel, A. T. Allair, 15 cents; Buras, A. J. McPhail, 15¼ cents. (The last two were awarded last week.)

Under the supervision of the Board of Commissioners of the Fifth Louisiana District: Raleigh and Reid, Geo. Arnold & Co., 19 and 27 cents; Wylie and Lee, John McGinty, 20 and 22 75 cents; Monona, A. P. Martin, 21.5 cents.

**The Buffalo Trunk Sewer.**—Col. George E. Waring, Jr., has sent in his final report on the construction of the "trunk" sewer of Buffalo, N. Y. We give the following general abstract:—July 29, 1880, Messrs. Youngs, Adams and Lane reported a plan for a trunk sewer in Buffalo, to be substantially 11 feet in diameter, and in part on the line of the present sewer; December 21, 1884, Messrs. Smith, Chesbrough and Shedd made a report recommending a sewer, 9 feet 8 inches, 11 feet 7 inches, and 11 feet 11 inches in diameter in its three sections. On August 17, 1882, Col. Waring recommended a sewer 8 feet in diameter. The purpose of this sewer was to remove promptly in a constant stream of sufficient depth and velocity the dry weather flow of all the city sewers lying practically north of Hamburg canal and Little Buffalo creek as far as the crest separating the main area of the city from the Bird avenue sewer district. Its velocity of flow to be not less than 2 feet per second. It was to be also large enough to transport a very large proportion of the storm water flow of the city sewers. Water was drawn from the Hamburg canal to provide a constant flow. This sewer as built is 8 feet inside diameter and has a fall of 1 foot in its 4,656 feet of length, or about 13 inches to the mile. There are three flushing inlets, each provided with automatic gates, allowing the water to pass freely from the canal into the sewer but preventing the reverse flow. The actual cost of the sewer, including right-of-way, preliminary surveys, plans and the construction of the Bird avenue junction chamber has been $1,035,023.88 Col. Waring in the same report suggests plans for the purification of the Hamburg canal which is underlaid by foul deposits or decaying organic matter.

## MARKET SUMMARY.

The Brick Market is about as last week as far as prices are concerned, but there has been an active demand during the past few days, and prices are stiff at $7 50@7.75 per M. for Haverstraw firsts, $7.00@7.25 for seconds, and some choice brands at $8.00 per M. Up Rivers continue to move readily at $6.75@7.00, and Pals sell at $4.75@5 00 per M.—Face brick show no change in price. Philadelphia and Trenton quoted at $24@$25 00 per M. alongside wharf and Baltimore $37@$41.00 per M. Rosendale cement is very active and stiff at $1.10 per barrel, the requirements of the aqueduct will probably be large during the next few months. Portland cement shows only the ordinary variations in price caused by difference in quantities and brands, with prices varying from $2 10@$2.40 per barrel. Lime has been a scarce article on the Market, but the price is unaltered. Plaster and Hair are in good demand at old quotations. The Lumber Market is fairly active, prices are running very evenly, and Spruce Randoms are still quoted $14@$16.00 per M. with some poor sized schedules at $13 50, heavy sized special schedules fetch as high as $18.00 per M. Yellow Pine $18@$19 50 for random cargoes, specials, $19.50@$21.00 per M. Lath have sold in large quantities at $2.25 for large cargoes of Spruce, and $2.30 for small lots of St. John. Paints show no variation in price, Linseed Oil however, has had a heavy drop, and city has been sold at 39c. per gallon, and Western as low as 36c. per gallon. Turpentine is not so firm and has been sold this week as low as 36½c. per gallon. There have been no encouraging features in the Hardware Market, and dealers do not appear to care about stocking up heavily. Nails meet with only a moderate inquiry at prices ranging from $1.95@$2.00 per keg. Lead is in good demand and firm at the improved price of 4½c. Pig Tin is not so firm this week, and sales are reported at 22.10c. for Straits, Banca 23c. nominal. Tin Plate shows no improvement, and prices are rather weak at quotations of I. C. charcoal ½-cross assortment, $4.60@$4.65 for Allaway, and $5.15@$5.20 for Melyn grade. Tar and Pitch is in rather moderate demand at $1.40@$1.70 per barrel for Pitch, and $1.90@$2.40 per barrel for Tar according to quantity, quality and delivery.

## BUILDING ITEMS.

Mr. Chas T. Wills has been awarded the contract for the erection of a handsome flat 75x100, to be built on the southeast corner of Sixty-sixth street and Fourth avenue, from plans of Mr. Henry J. Hardenbergh.

Mr. W. W. Kent, manager of the New York office of Harvey L Page, of Washington, in Temple Court, reports on the boards plans for a residence to be built for Mr. John A. Stewart, Jr., at Short Hills, N. J., to cost $15,000; also a $7,000 residence to be built for Dr. Green, at Sayville, L. I., two houses, to be built at a cost of $21 000, on President street, Brooklyn, for Messrs. Johnson & Lamb, and an $8,000 residence, to be built for Parker W Page, at Summit, N. J.

Messrs. J. W. Hogencamp & Son have been awarded the contract for the erection of the "Mission church for Seamen," 40x73, to be built adjoining the corner of Houston and West streets, from plans of Mr. Chas. C. Haight.

Mr. W. E. Mowbray has prepared plans for a first-class, four story, brown stone residence, to be erected by Mr. Anthony Mowbray, on the south side of Seventy-eighth street, 100 feet east of Fifth avenue.

Mr. H. J. Campbell has prepared plans for three two-story brick and frame dwellings, 16 8x52 each, to be built by Mr. D. J. Weir, at a cost of about $17,500 on Hawthorn street, Yonkers.

Mr. E. D. Lindsey is the architect for improvements to be made to No. 835 Fifth avenue, for Mr. Amos Cotting, which will cost $7,000.

Mr. G. A. Schellenger has completed plans for ten four-story and basement brick dwellings, 20x65, to be built for Mrs. Margaret Crawford, on the south side of Eighty-ninth street, 100 feet east of Ninth avenue, at a cost of $150,000—he is also the architect for four five-story brick and terra-cotta flats, to be built on Seventy-third street, 200 feet west of Avenue A, for Mr. E. Stanley Cornwall, at a cost not yet estimated.

Mr. John C. Burne has prepared plans for Mr. H. Chenoweth, for seven five-story brick, stone and terra-cotta flats with stores, to be built at a cost of $137,000, on the northwest corner of Ninety-ninth street and Second avenue.

Mr. Edward Kilpatrick will build from his own designs on the west side of Madison avenue 92 feet north of Eightieth street, two four-story and basement brick dwellings, 20x55.6 at a cost of $30,000.

Mr. J. H. Valentine has drawn plans for three five-story brick tenements, 25x90 each, to be built for Mrs. Ella A. Treacy, on the north side of Ninety-sixth street, 100 feet west of Third avenue, cost $45,000; he is also the architect for a three-story and basement brick residence, 20x65, to be built for Mrs. Sarah E. Hinman, on the north side of ninety-eighth street, 80 feet east of Tenth avenue, to cost $12,000.

Mr. Max Schroff has designed for Mr. John Wendel, a three-story iron front commercial building, to be built at a cost of about $30,000, on the northwest corner of Thirty-eighth street, and Broadway.

Mr. Henry Rutgers Marshal, reports that he has completed plans for another warehouse, to be built adjoining the one recently built from his designs on Hubert street, near West. Owners, Brower estate.

Mr. C E Hebberd has designed for Mr. J. Kemp, four cottages to be built on Howard avenue, Brooklyn, at a cost of $10,000.

Mr. Andrew Spence is the architect for five four-story brick tenements, 24x55 each, to be built for Mr. James T. Magher, on the south side of One-hundred and Thirty-sixth street, 100 feet west of Alexander avenue, to cost $50,000.


## Statistical Tables of American Water-Works.

The following is the list of advertisers, received up to 10 A. M. Friday, 12th Nov.

R. D. WOOD & CO., Philadelphia, Pa., Cast-Iron Water and Gas Pipes and Hydrants.
HENRY R. WORTHINGTON, New York City, High Duty Pumping Engines and Water Meters.
GLOUCESTER IRON WORKS, Philadelphia, Pa., Cast-Iron Water and Gas Pipe.
WARREN FOUNDRY & MACHINE CO., Phillipsburg, Pa., Cast-Iron Water and Gas Pipe.
SOUTHWARK FOUNDRY & MACHINE CO., Philadelphia, Pa., Pumping Engines.
DONALDSON IRON CO., Emaus, Lehigh Co., Pa., Cast-Iron Water and Gas Pipe, etc.
THE EDDY VALVE CO., Waterford, N. Y., Valves and Hydrants.
WATER & GAS WORKS CONSTRUCTION CO., Pittsburgh, Water-Works Contractors.
SAMUEL R. BULLOCK & CO., New York City, Water-Works Contractors.
G. J. ROBERTS & CO., Dayton O., Steam Pumps.
AMHERST HYDRAULIC MOTOR CO., Holyoke, Mass., Water Engines.
LAKE SHORE FOUNDRY, Cleveland, O., Cast-Iron, Gas and Water Pipe.
SILSBY MANUFACTURING CO., Seneca Falls, N. Y., Steam Fire Engines.
MELLERT FOUNDRY & MACHINE CO., Reading, Pa., Cast-Iron Water and Gas Pipe.
SAYRE PIPE FOUNDRY, Sayre, Pa., Cast-Iron Gas and Water Pipe.
HOLYOKE HYDRANT & IRON WORKS, Holyoke, Mass., Fire Hydrants.
HERSEY METER COMPANY, South Boston, Mass., Water Meters.
WALTER S. PAYNE & CO., Fostoria, O., Water-Works Supplies.
A. H. HOWLAND, Boston, Mass., Water-Works Contractor.
FRED. ADEE & CO., New York City, Stop Cocks
LUDLOW VALVE MANUFACTURING CO., Troy, N. Y., Valves and Hydrants.
GOULDS & AUSTIN, Chicago, Ill., Plumbing and Water-Works Supplies.
SPRINGFIELD FOUNDRY CO., Springfield, Mass., Fire Hydrants.
THOS. KELLY & BROS., Chicago, Ill., Self-Acting Water Closets.
OHIO STREET LIGHTING CO., Canton, O., Street Lighting Contractors.
INMAN BROTHERS, New York City, Water and Gas Works Contractors.
WHITTIER MACHINE CO., South Boston, Mass., Water-Works Supplies.
ERSKINE W. FISHER, New York City, Portland Cement and German Asphalt Mastic.
HOWARD CHILDS & CO., Pittsburgh, Pa., Cast and Wrought-Iron Pipe and Water-Works Supplies.
E. R. DAVENPORT, Charleston, W. Va., Gas and Water-Works Contractor.
ALBERT L. WEBSTER, New York City, Sanitary Engineer.
AMERICAN WELL WORKS, Aurora, Ill., Artesian Well Contractors.
H. A. CARSON, Boston, Mass., Sewer Excavating Machines.
RANDALL FOOTE, New York City, Broker for Water-Works Securities.
OTTO GAS ENGINE WORKS, Philadelphia, Pa., Gas Engines.
BOURBON COPPER & BRASS WORKS, Cincinnati, O., Hydrants and Valves.
D. T. HUBBELL, Pethel, Conn. Eureka Tapping Machine.
CALVIN TOMKINS, New York City, General Construction Supplies.
TUERK HYDRAULIC POWER CO., New York City, Tuerk Water Motor.
STEBBINS MANUFACTURING CO., Springfield, Mass., Brass Goods, Stops and Cocks.
BASSETT BROS., Buffalo, N. Y., Water-Works Engineers and Contractors.
ALAN MACDOUGALL, Toronto, Canada, Sanitary Engineer.
E. DELEVAN SMALLEY, Canastota, N. Y., Water-Works and Sewers.
E. C. TERRY, Hartford, Conn., Bi Piston Water Meters
RANDOLPH BRANDT, New York, Selden's Patent Packings.
NATIONAL TUBE WORKS CO., McKeesport, Pa., High Pressure Water and Gas Pipe.
FOWLER & CO., Louisville, Ky., Cocks and Ferrules and Phosphor Bronze Castings.
HENRY F. JENKS, Pawtucket, R. I., Drinking Fountains.
WALWORTH M'FG Co., Boston, Mass., Wrought-Iron Pipe, etc. Tapping Machines and Stop Cocks.
COFFIN VALVE CO., Boston, Mass., Valves and Hydrants.
WATER, LIGHT & POWER CO., St. Louis, Mo., Contractors for Water, Gas and Electric Light Works.
J. N. RAYMOND, Chicago, Ill., Lead Pipe and Sheet Lead. Pig Lead for Caulking.
JOHN McLEAN, New York City, Fire Hydrants and Stop Cocks.
ABENDROTH & ROOT MANUFACTURING CO., New York City, Spiral Riveted Pipe.
PANCOAST & ROGERS, New York City, Water and Gas Works Supplies.
JOHN LOCKWOOD, New York City, Hydraulic and Gas Engineer and Contractor for Water-Works.
COMEGYS & LEWIS, New York City, Contractors for Water and Gas Works.
R. E. WILLIAMS, Jackson, Mich., Engineer for Water-Works and Sewerage.
W. J. DRUMMOND, New York City, Water and Gas Works Supplies.
NATIONAL METER CO., New York City, Water Meters and Gas Engines.
S. E. BABCOCK, Little Falls, N. Y., Water-Works, Hydraulic and Sanitary Engineer.
WHITE & RAEDER, New York City, Engineers for Architectural and Sanitary Works.
CHESTER B. DAVIS, Chicago, Ill., Hydraulic and Sanitary Engineer.
THE JACKSON & WOODIN M'FG. CO., Berwick, Pa., Cast-Iron Water and Gas Pipe and Car Wheels.
ARTHUR WINSLOW, Raleigh, N. C., Civil and Mining Engineer.
POND ENGINEERING CO., St. Louis, Mo., Pumping Machinery.
THE WELLS RUSTLESS IRON CO., New York, Wrought-Iron Pipe.
THE NEWARK FILTERING Co., New York, Hyatt Filters.
SAMUEL A. STRANG, New York, Deacon Waste Water Meter.
THE HOLLY MANUFACTURING CO., Lockport, N. Y., Gaskill Pumping Engine.
FRANCIS H. SMITH, New York, Water-Works Securities, Building Dams.
AMERICAN WATER-WORKS AND GUARANTEE CO., Muncie, Ind., Water-Works Construction, etc.
CHAPMAN VALVE MANUFACTORING CO., Indian Orchard, Mass. Valves and Hydrants.
HENRY A. WARNER, New Haven, Conn., Vitrified Sewer Pipe.
FRONTIER IRON AND BRASS WORKS, Detroit, Mich., Weber's Gate Valve, and Hydrants.
JOHN C. CHASE, Wilmington, Del., Hydraulic & Sanitary Engineer.
THE AERIFILTER CO. Chicago, Ill., Filters and Water Cooler.
ISAAC S. CASSIN, Philadelphia, Pa., Hydraulic Engineer.
I. S. CASSIN & CO., Philadelphia, Pa., Cast Iron Water and Gas Pipe.
THE BRIGHTMAN STOKER CO., Cleveland, O., Mechanical Stoker.
S. P. JONES, Boston, Mass., Pressure Recording Gauges.

Address all correspondence to

ENGINEERING NEWS PUBLISHING COMPANY,
12 Tribune Building, New York.